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WIND AND RADIATION

By W. J. HUMPHREYS

[Washington, D. C., December 1938]

Naturally, one might suppose that, in general, the radiative loss of heat by the surface of the earth and lower air on clear nights must be the same whatever the wind, calm to gale. It is true that the perviousness of the air to all radiation, ultraviolet, visible, and ultrared, is the same regardless of its motion. Therefore, if everything else were the same, the losses of heat would be equal in the two cases under consideration; but they are not the same, for the temperatures of the surface and of the lower air are affected by the strength of the wind. Where the air is calm the supply of heat to the cooling surface, apart from that conducted up from below, comes from only a very thin layer of the superjacent air, whereas on windy nights it comes, owing to turbulence, from a much deeper layer of this air. Hence, from that cause alone, the surface would be warmer on a windy night than it would have been if the air had been calm. There is also another effect of the wind to take into account that still further increases this temperature difference, namely, the complete mixing of the air of the turbulent layer, by which it is brought to a common potential temperature—its lapse rate made adiabatic instead of being left subadiabatic—and the surface air thus brought to a higher temperature than it would have if calm.

Obviously, then, the surface of the earth and the adjacent air must be, and they are, colder during calm nights than on windy nights. But the loss of heat by radiation from the surface of the earth (practically a full radiator) varies closely as the fourth power of its absolute temperature. Hence, in general, on clear nights the earth radiates a greater quantity of heat when there is a strong wind than it does when the air is calm, but does not come to as low a temperature.

MINIMUM TEMPERATURES DURING SPRING AND AUTUMN AT LINCOLN, NORTH PLATTE, AND SCOTTSBLUFF, NEBR.

By HARRY E. HOY

[University of Illinois, Urbana, Ill., June 1938]

INTRODUCTION

The purpose of this study[1] is to determine the minimum temperatures during the transition periods of spring and autumn at three selected stations in Nebraska. The latest date of freezing temperature ever recorded at Lincoln is May 15 (1907); but the fact that a killing frost has never occurred after this date is not evidence that one never will. The writer, by a detailed study of the 39 or more minimum temperatures for each date, has attempted to determine what the probability of a killing frost is for each day, from reasonable frost-certain to reasonable frost-free dates during spring, and from frost-free to frost-certain dates in autumn.

It is generally known that killing frosts occur on the majority of March days in Nebraska. As spring progresses the occurrences of freezing temperatures become less frequent, so that by June 1, the temperature rarely falls below 32° F. The three stations chosen are representative of the eastern, central, and western parts of the State. Since altitude is a more important modifier of growing season in Nebraska than latitude, an east-west line of stations was believed more desirable than a north-south line. The stations have kept continuous records for periods of 39 to 45 years. The three stations are about equally separated from each other by both altitude and latitude. Scottsbluff at altitude 3,888 feet is the northernmost, latitude 41°50′ N. North Platte, altitude 2,821, is at latitude 41°10′; Lincoln, altitude 1,189, is located at latitude 40°41′. Scottsbluff experiences temperatures and amounts of precipitation which are about the lowest in the State; North Platte's are slightly below the average; at Lincoln they are slightly below the State maximum.

A killing frost is interpreted in this paper to mean a temperature of 32° F. or below, since in a statistical study it is felt that an objective definition of killing frost is more desirable for comparing conditions at different stations and at different times. This results occasionally in small differences between the dates of first and last killing frosts published by the United States Weather Bureau and the dates used in this study. The determination of a killing frost using the presence of frost crystals with freezing destruction to certain plants as indicators is no doubt of more practical importance to growers than is a temperature of 32° F. However, the unavoidable subjective element where several different observers report with different plants as indicators and at different times in the season, although perfectly defensible from a practical point of view, might be a bit indefinite in a statistical paper such as this. Both definitions are recognized as acceptable. Therefore, "freezing temperature" and "killing frost" will be terms used synonymously hereafter in this paper.

[1] See also Earl E. Lackey: Variability Isocrymal Maps for the Great Plains. MO. WEA. REV. 64: 70-76, March 1936.

Statistical methods are employed in organizing and applying the data used. All computations are based on the actual minimum temperatures for each day as compiled by the United States Weather Bureau. It was assumed that the distribution of 40 or more minimum temperatures for a given date would closely approximate a normal curve. This was borne out by later investigation. First, the standard deviation or the temperature range expected 68 percent of the time was determined. This was found by the application of the formula:

$$\text{Standard deviation}=\sqrt{\frac{\Sigma T^2}{N}-A^2}$$

where T is minimum temperature, N is the number of observations, and A is the average minimum temperature. By means of the standard deviation the following results were obtained for each date during the 6 months at Lincoln, North Platte, and Scottsbluff:

1. Average minimum temperature.
2. Limits of standard deviation.
3. Probability of a freezing temperature.
4. Lowest temperature expected 1 and 2 percent of the time.

In addition to these, two other sets of data were worked out which also served as a check on the mathematical method used. They are (1) the lowest recorded temperature and (2) the probability of a frost after any date in spring and before any date in autumn. The lowest temperature expected 2 percent of the time would mean in the case of the data used, which covers about 50 years, a single occurrence of that temperature during the period. The lowest recorded temperature on that date bears out this assumption very well. Only in relatively few instances does the lowest recorded temperature vary more than 3° or 4° from the temperature expected, on the average, 1 year in 50. The averages of the lowest temperatures recorded and the lowest expected 2 percent of the time, are nearly identical.

CONDITIONS AT LINCOLN

Lincoln was selected as representative of the eastern part of Nebraska. Here the frost-free period is nearly as long as that found anywhere in the State. The transition periods between winter and summer, and summer and winter, are earlier in spring and later in autumn than at the other two stations. With reference to figure 5 (graph showing spring conditions of minimum temperature in Lincoln, Nebr.) it is seen that the average minimum temperature ranges from 20.7° F. on March 1, to 34° F. on April 1, to 45° F. May 1, to 55° F. on May 31. While this general climb is taking place, there are many small irregularities. It is believed that a 46-year record is not long enough to smooth out all of the irregularities that might be caused by one or two extremely high or low minima.

The irregularities of day-by-day temperature change in autumn are less severe than are those of spring. The average daily drop is greatest in September and least in November; the opposite is true in spring, when March has the most rapid and May the least rapid rise. The average rate of daily increase in spring is 0.375° while the average daily decrease of autumn is 0.416°.

The limits of standard deviation are greatest early in spring and late in autumn because of the greater extremes of temperature that occur near the winter season. From March 1 to March 25 the average deviation is from 10° to 12°. After March 27 and until May 25 the usual deviations are about 8°. The usual deviation after May 25 is less than 7°. The table below illustrates the average standard deviations by months and by seasons.

Month	Average standard deviation	Month	Average standard deviation
	°		°
March	10.25	September	9.27
April	8.53	October	9.34
May	7.29	November	9.02
Average (spring months)	8.66	Average (autumn months)	9.21

The probability of a freezing temperature on March 1 is 85 percent. This high probability becomes gradually less until by April 1 it has dropped to 40 percent. On April 15 the probability is 16 percent, 10 percent on May

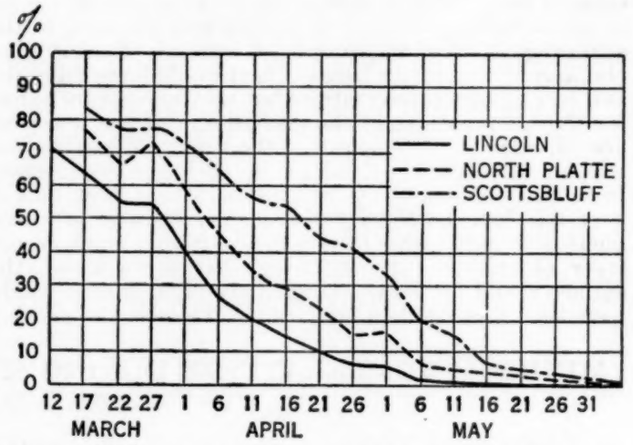

FIGURE 1.—Probability of a freezing temperature during spring. (Probabilities on dates indicated have been averaged with those of the dates on either side.)

1, and by May 15 only 1 percent. On May 31, the last day shown on the graph, the probability is less than 0.05 percent or a probable occurrence of about once in 2,000 years.

During autumn the probability of frost occurrence is only once in 10,000 years on September 1 but on September 15 the probability is 1 percent; October 1, 3.5 percent; November 1, 33 percent; and November 30, 80 percent. Figures 1 and 2 illustrate the decrease and increase,

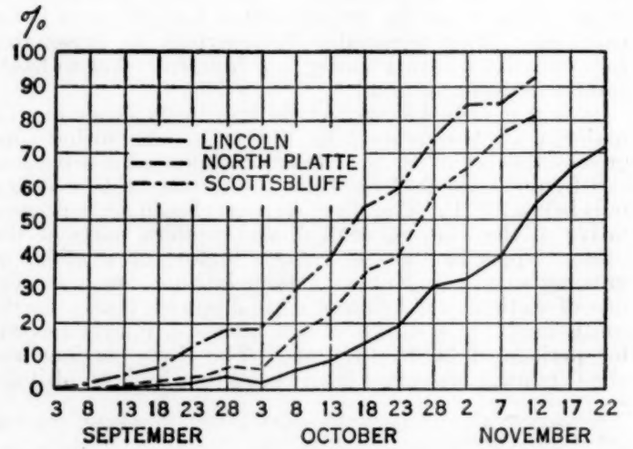

FIGURE 2.—Probability of a freezing temperature during autumn. (Probabilities on dates indicated have been averaged with those of the dates on either side.)

respectively, of frost probability in spring and autumn at Lincoln, North Platte, and Scottsbluff.

TABLE 1.—*Probability of a killing frost after any date in spring at Lincoln*

Date	Percent probable	Date	Percent probable	Date	Percent probable
Mar. 25	99.5	Apr. 14	67.0	May 4	8.6
Mar. 26	99.3	Apr. 15	63.7	May 5	7.2
Mar. 27	98.9	Apr. 16	60.3	May 6	6.1
Mar. 28	98.5	Apr. 17	56.8	May 7	5.1
Mar. 29	98.1	Apr. 18	53.2	May 8	4.2
Mar. 30	97.6	Apr. 19	49.6	May 9	3.4
Mar. 31	96.4	Apr. 20	46.1	May 10	2.8
Apr. 1	95.5	Apr. 21	42.5	May 11	2.3
Apr. 2	94.7	Apr. 22	39.0	May 12	1.8
Apr. 3	93.7	Apr. 23	35.5	May 13	1.5
Apr. 4	92.5	Apr. 24	32.2	May 14	1.2
Apr. 5	91.2	Apr. 25	29.1	May 15	.9
Apr. 6	89.6	Apr. 26	26.1	May 16	.7
Apr. 7	87.7	Apr. 27	23.2	May 17	.5
Apr. 8	85.9	Apr. 28	20.5	May 18	.4
Apr. 9	83.7	Apr. 29	18.1	May 19	.3
Apr. 10	79.0	Apr. 30	15.8	May 20	.2
Apr. 11	76.3	May 1	13.7	May 21	.2
Apr. 12	73.4	May 2	11.8	May 22	.1
Apr. 13	70.3	May 3	10.1	May 23	.1

TABLE 2.—*Probability of a killing frost before any date in autumn at Lincoln*

Date	Percent probable	Date	Percent probable	Date	Percent probable
Sept. 7	0.1	Oct. 1	14.2	Oct. 24	79.1
Sept. 8	.1	Oct. 2	16.1	Oct. 25	81.6
Sept. 9	.2	Oct. 3	17.9	Oct. 26	83.2
Sept. 10	.3	Oct. 4	20.5	Oct. 27	85.1
Sept. 11	.4	Oct. 5	22.8	Oct. 28	87.0
Sept. 12	.5	Oct. 6	25.3	Oct. 29	88.6
Sept. 13	.6	Oct. 7	28.0	Oct. 30	90.0
Sept. 14	.7	Oct. 8	30.8	Oct. 31	91.5
Sept. 15	.9	Oct. 9	33.7	Nov. 1	92.8
Sept. 16	1.1	Oct. 10	36.7	Nov. 2	93.3
Sept. 17	1.4	Oct. 11	39.8	Nov. 3	94.9
Sept. 18	1.7	Oct. 12	43.0	Nov. 4	96.2
Sept. 19	2.1	Oct. 13	46.2	Nov. 5	96.8
Sept. 20	2.5	Oct. 14	49.4	Nov. 6	97.3
Sept. 21	3.0	Oct. 15	52.6	Nov. 7	97.8
Sept. 22	3.6	Oct. 16	55.9	Nov. 8	98.2
Sept. 23	4.3	Oct. 17	59.1	Nov. 9	98.3
Sept. 24	5.1	Oct. 18	62.2	Nov. 10	98.5
Sept. 25	6.0	Oct. 19	65.2	Nov. 11	98.8
Sept. 26	7.0	Oct. 20	68.2	Nov. 12	99.0
Sept. 27	8.2	Oct. 21	71.0	Nov. 13	99.2
Sept. 28	9.5	Oct. 22	73.7		
Sept. 29	10.9	Oct. 23	76.4		
Sept. 30	12.5				

The two broken lines on the plates represent the temperatures expected 2 percent and 1 percent of the years on that date. These values are statistical probabilities

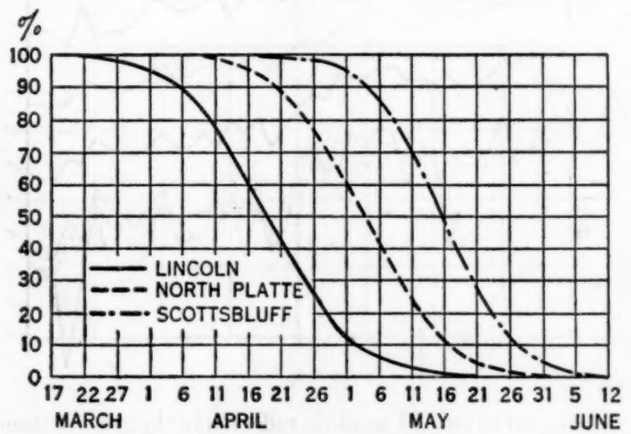

FIGURE 3.—Probability of a killing frost after each date in spring at Lincoln, North Platte, and Scottsbluff.

based on the standard deviation for that date. A standard deviation greater or less than the usual deviations causes the 1- or 2-percent probability points to be too low or too high respectively. A study of those lines as a whole is more valuable than the individual day-by-day values.

As might be expected the range of minimum temperatures is greatest in early spring and late autumn. The average range between the average minimum temperature and the average lowest recorded temperatures in March is 26° while that of May is 16.2°. In September the average variation is 17.3° and in November 22.2°.

March 15 is so early in the spring that a killing frost is expected to occur several times before summer, while the probability of a frost after May 31 is practically zero. The probabilities of frost after each date in spring and before each date in autumn are given in tables 1 and 2. This theoretical probability is determined by the use of the normal distribution curve applied to the dates of the first and last killing frosts. The earliest last killing frost of spring ever recorded is March 27 (1925) and the latest May 15 (1907). The probabilities of having a freezing

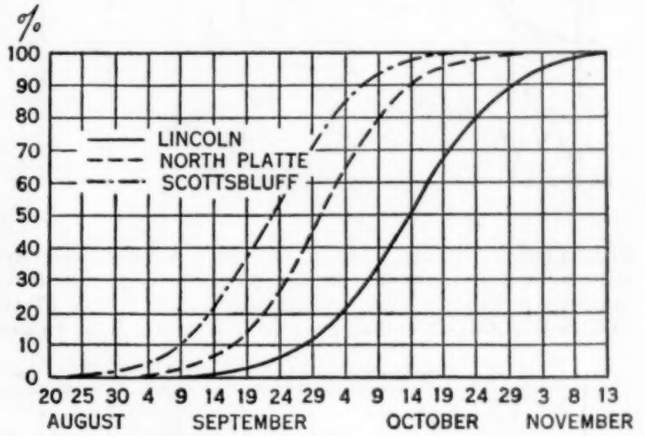

FIGURE 4.—Probability of a killing frost before each date in autumn at Lincoln, North Platte, and Scottsbluff.

temperature after these dates are 98.9 percent and 0.9 percent respectively. The dates of the earliest and latest recorded killing frosts of autumn are September 18 (1901) and November 7 (1924). The interval between the earliest and the latest last killing frost in spring is 49 days while the same interval between the earliest and latest first killing frost in autumn is 50 days. Actually as well as statistically 68 percent of the last and first freezes are clustered within 11.5 days of the average last and first killing frost dates, which are April 18 and October 17, respectively. Thus the average frost free season is 179 days. The limits of standard deviation of the last killing frost in spring are between April 9 and April 30 and of the first in autumn between October 2 and October 26. This means that there is less than a 16 percent chance that a last killing frost will occur before April 9 and after April 30 or that the first freeze of autumn will occur only 16 percent of the time before October 2 and after October 26. The shortest actual growing season ever recorded is 150 days (1907) while the longest is 219 days (1924). It is fortunate that the large majority of last and first killing frosts occur near the average data. This makes possible a fuller use of the growing season by crops requiring a long period for growth.

COMPARISON OF THE THREE STATIONS

The same study was made of the minimum temperatures at North Platte and Scottsbluff as at Lincoln. The same conditions as above interpreted for Lincoln are illustrated by figures 7, 8, 9, and 10. A brief summary will suffice to make a comparative study of the three stations possible. The periods studied at North Platte and Scottsbluff extended from March 15 to June 15 and August 15 to November 15. Similar temperature conditions occur about 15 days earlier in spring and 15 days later during autumn at Lincoln than at North Platte. During the period from March 20 to May 31 the average minimum temperatures increase from 29° to 55° at Lincoln, from 25° to 50° at North Platte, and from 24° to 47° at Scottsbluff. During autumn the approach of winter occurs earliest at Scottsbluff. Freezing temperatures occur 2 weeks earlier at North Platte, and from 3 to 4 weeks earlier at Scottsbluff, than at Lincoln.

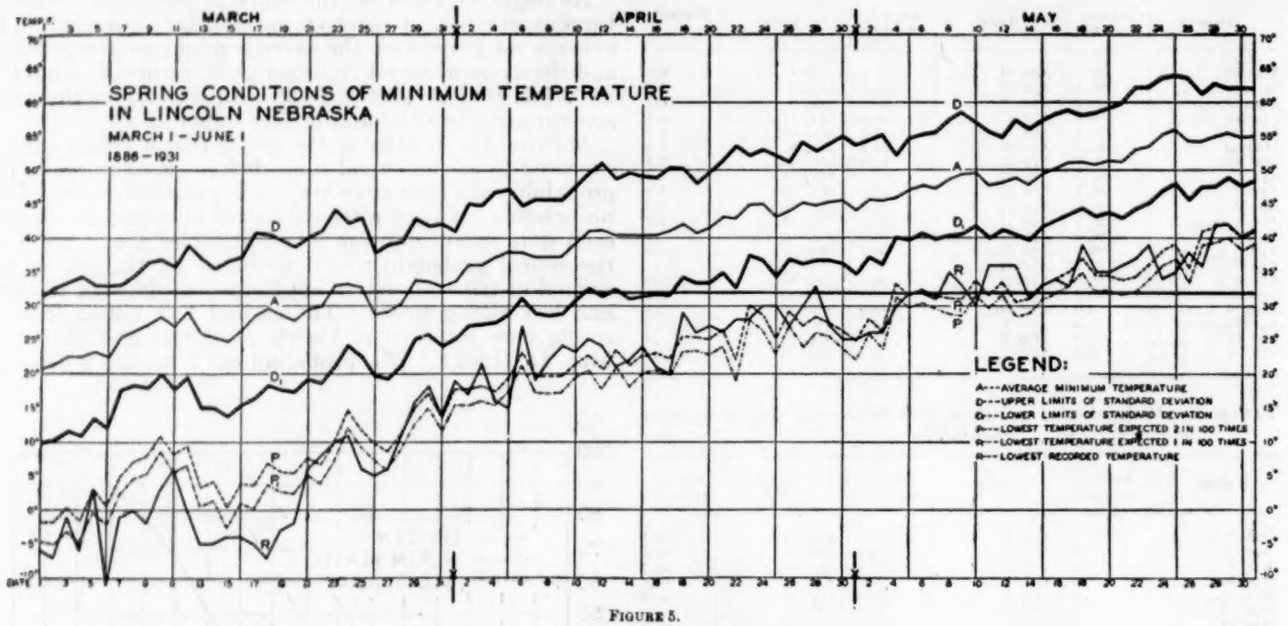

FIGURE 5.

The least variation between the lowest recorded temperatures and the average minimum temperatures occurs at Scottsbluff and the greatest variation at Lincoln. March and November extremes vary the most at all stations. The greater variation at Lincoln is reflected in the greater standard deviation found there. The spring season average shows an 8.68° variation at Lincoln, 7.70° at North Platte, and 7.71° at Scottsbluff. The autumn average standard deviations in the same order are 9.24°, 7.34°, and 7.05°.

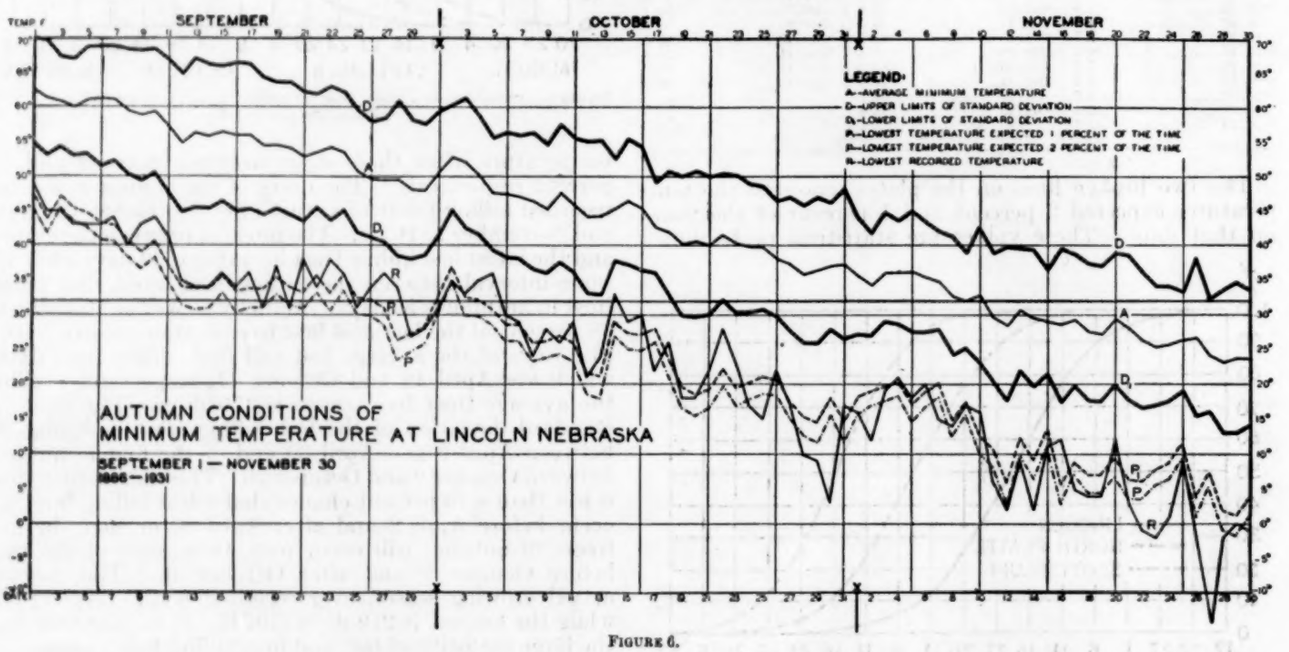

FIGURE 6.

The approach of summer and winter is slightly more rapid in the east than in the west. The average daily change of average minimum temperatures at Lincoln is 0.375° in spring and 0.416° in autumn, while the same change at Scottsbluff is 0.365° and 0.376°, respectively.

The probability of a freezing temperature during spring and during autumn at the three stations is illustrated by figures 1 and 2. The rate and time of advance of summer and winter are clearly distinguished at each point. For example May 15 at Lincoln is a fairly safe time to place fragile plants out of doors because the probability of a freezing temperature is less than 1 percent. At North Platte a freezing temperature can be expected over 16 percent of the time while at Scottsbluff the chances of frost damage would be great, as more than half the years have experienced a killing frost after May 15.

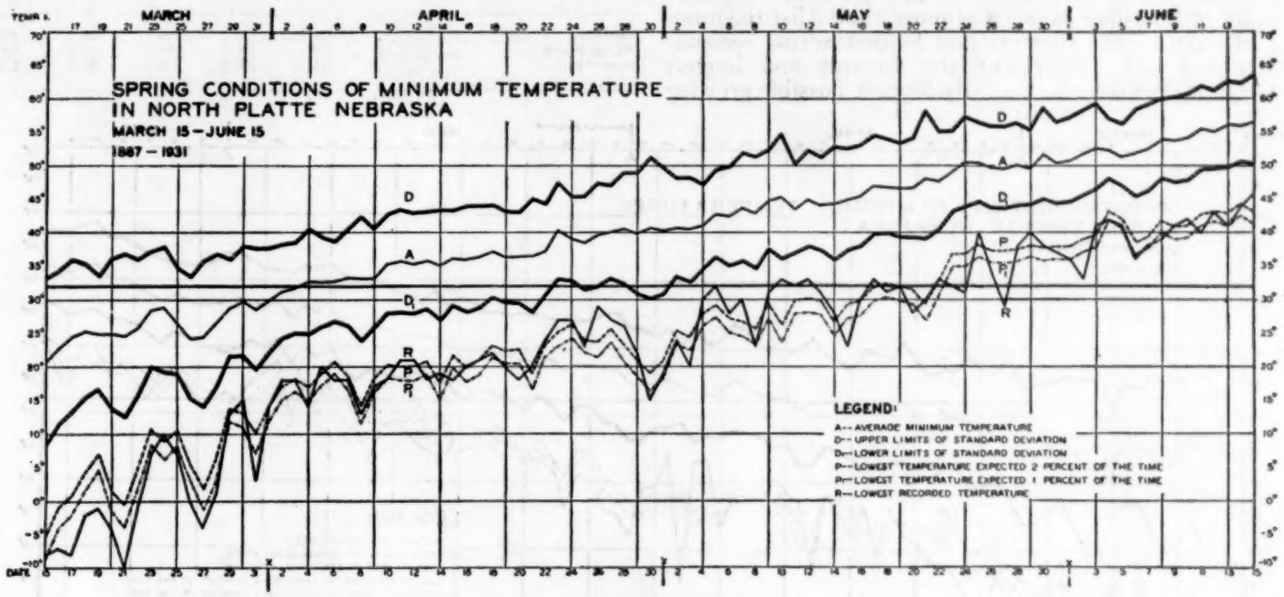

FIGURE 7.

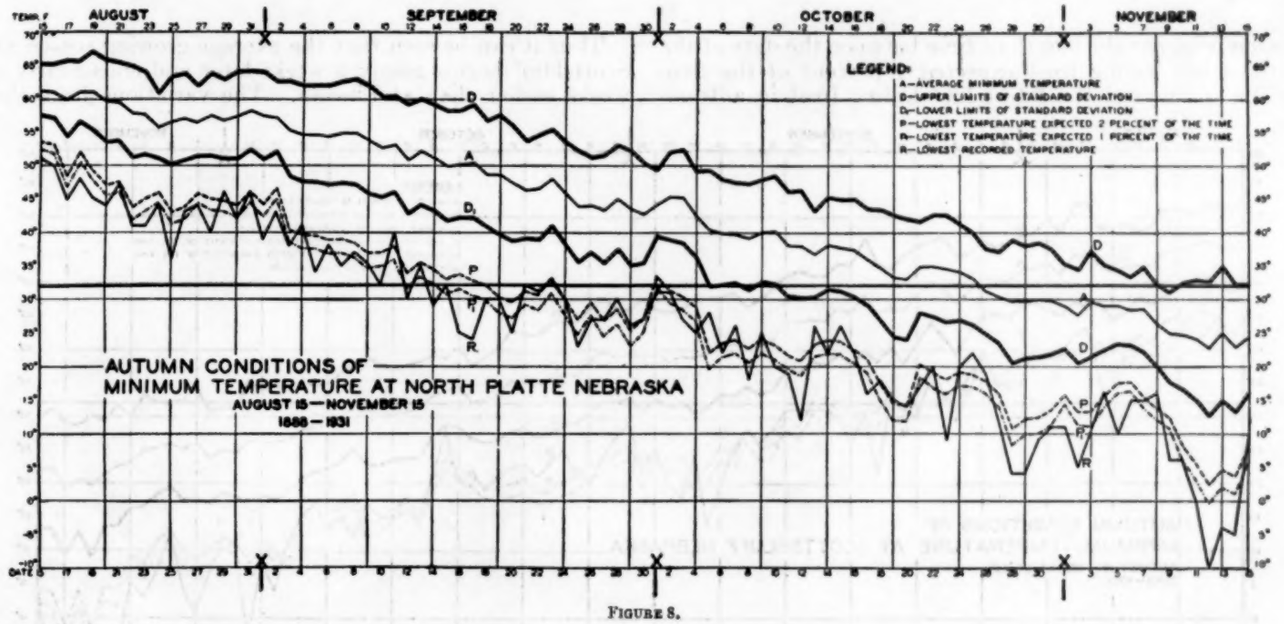

FIGURE 8.

The probability of a killing frost after each date in spring and before each date in autumn is shown in figures 3 and 4. This is to be distinguished from the probability on each date given in figures 1 and 2.

The length of the average frost-free season at Lincoln is 179 days, at North Platte 150, and at Scottsbluff 131. The accompanying table is made up of actual as well as theoretical data. The first column gives the average number of frost-free days. Columns 2 and 3 list the number of days in the shortest and longest actual seasons. Columns 4 and 5 represent the shortest and longest theoretical growing seasons. By longest possible growing season is meant the length of time between the date of the earliest last killing frost expected 1 percent of the time in the spring and the latest first killing frost in autumn that would likely occur 1 percent of the time. It is obvious that a season as long as this, or as short as between the latest possible and earliest possible autumn freeze, would be a rarity.

Station	Average number of frost-free days	Shortest actual season (days)	Longest actual season (days)	Shortest theoretical season (days)	Longest theoretical season (days)
Lincoln	179	150	219	124	230
North Platte	150	106	196	99	200
Scottsbluff	131	106	151	85	178

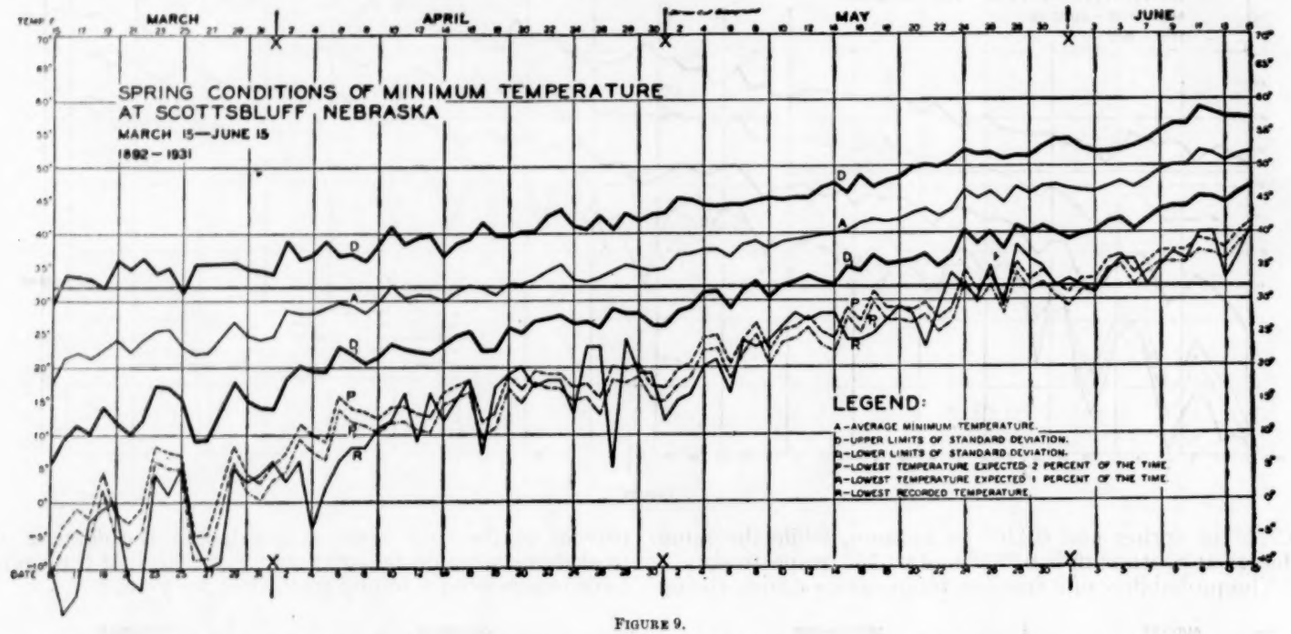

FIGURE 9.

Thus it can be seen that the average growing season at Scottsbluff begins nearly 3 weeks later and ends nearly 3 weeks earlier than at Lincoln. The variations from the average or the unreliability of the frost-free season is greatest at Scottsbluff and least at Lincoln even though the standard deviation of minimum temperature is less at Scottsbluff than at North Platte or Lincoln.

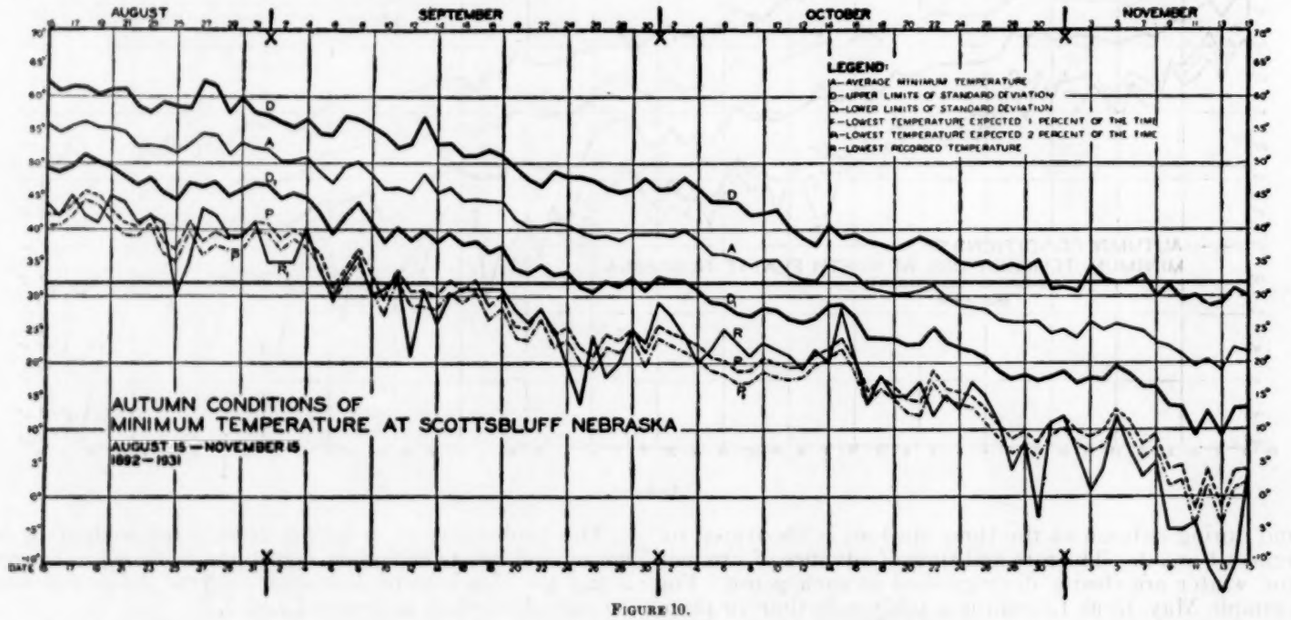

FIGURE 10.

THE DIURNAL VARIATION OF SUMMER RAINFALL AT DENVER

By ALBERT W. COOK

[Weather Bureau Office, Denver, Colo., February 1939]

At Denver, Colo., practically all of the precipitation that occurs during November, December, January, and February is in the form of snow. Rain has been recorded a few times during these months, but it was of short duration or soon turned to snow. During March, April, and October considerable rain occurs, but the precipitation is chiefly in the form of snow. During the remainder of the year, May to September, inclusive, precipitation is chiefly rain, although considerable snow has fallen in May and September. The tipping-bucket gage cannot be used to measure snowfall; and hourly amounts of precipitation, therefore, are not available from October to April, inclusive. For that reason the diurnal variation in amounts and frequency for summer rainfall only will be discussed in this paper. In the last 20 years 55 percent of the precipitation has occurred during these 5 months.

Data for the 20-year period, 1919 to 1938, inclusive were used. It is believed that this period is of sufficient length to smooth most of the abnormalities due to excessive rains for short intervals of time.

The average hourly distribution of rainfall is shown graphically in figure 1. The same data are given in table 1. An examination of these data shows that the largest amounts occur in the afternoon and early evening hours. This characteristic is especially pronounced in July and August. The amounts for the hours ending at 5 p. m. and 9 p. m. in May appear to be much at variance, but these abnormalities can be accounted for by the occurrence of thunderstorms with excessive rainfall. In 1931, 1.02 inches fell between 4 p. m. and 5 p. m. Likewise in 1938, 1.58 inches fell between 8 p. m. and 9 p. m. Both occasions were associated with thunderstorms, and both amounts were equal to one-third of the the total fall during the 20-year period for the respective hours.

All months show a decided decline in average amounts between 11 p. m. and 1 p. m. The greatest average precipitation is 0.26 inch for the hour from 4 p. m. to 5 p. m. in August. The least amount, a trace, also occurred in August between 11 a. m. and noon. The total fall during this hour for the 20-year period was only 0.05 inch.

The duration of rainfall was approximated by considering the hours during which rain fell without regard to the exact time of beginning and ending. Thus, all computations were in multiples of 1 hour, and those hours wherein a trace only was recorded were kept separately. The total hours during which a trace of rain was recorded are shown in figure 2. Figure 3 shows the total number of hours in which 0.01 inch or more was recorded. To check more accurately the time of rainfall the actual beginnings and endings were considered during July for the entire 20-year period. This method of computation gave a total time equal to approximately 70 percent of that given by the first method in the case of measurable rains, 0.01 or more, and about 40 percent for traces only. Since the distribution curve is approximately the same by both methods, no additional computations were made for the other months.

The periods of maximum frequency for traces only and for 0.01 or more occur in the afternoon and early evening. The frequency curves have the same general trend as the curves showing the average hourly amounts of rain. Compare figures 1, 2, and 3.

The hour of greatest frequency, measurable amounts considered, is 5 p. m. to 6 p. m. in August. If traces only are considered the greatest frequency is in the hour from 4 p. m. to 5 p. m. in July. When the total frequency is considered, the maximum is from 4 p. m. to 5 p. m. in August. The hour of minimum frequency is from 4 a. m. to 5 a. m. in July. In the 20 years under discussion measurable rain occurred just twice during this hour. In other words the chances of rain in this hour are 2 in 620. Using traces only, the hour of minimum frequency is the hour just preceding the time of minimum frequency for measurable amounts, or 3 a. m. to 4 a. m. in July. Three traces were recorded in this hour in 20 years. Frequency data are shown in table 2.

An examination of the frequency charts reveals many interesting things. While it is conceded that measurable rains are of chief concern in the matter of outdoor activities, transportation, etc., any discussion of rainfall frequency should include traces along with the measurable

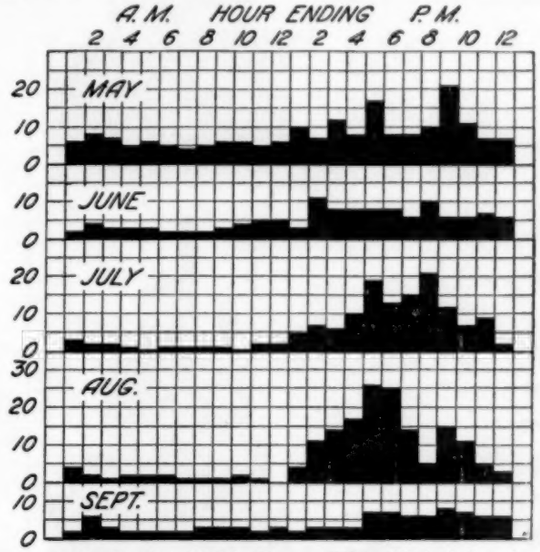

FIGURE 1.—Average hourly rainfall for 20 years, 1919 to 1938, inclusive. Amounts in hundredths of an inch.

amounts because often measurable amounts are simply the accumulated totals of preceding hours. Moreover, it has been found that traces at the official gage of the Weather Bureau are often accompanied by heavy showers nearby. This is shown very strikingly upon examination of the rainfall records of the city office, located in the heart of the business section of Denver, with those of the airport station, located about 5 miles east-northeast of the city office.

The outstanding feature of the frequency charts is the paucity of rain between 11 p. m. and 11 a. m. In order to show this better the actual number of times that rain occurred was plotted instead of the average for each hour. The average per hour for this period would be less than 1, traces only considered, in June, July, August, and September. The same holds true when measurable rains are considered, but is even more pronounced. There is a marked similarity in the trend of the curves for frequency and average hourly rainfall. Rainfall amounts during the night and forenoon are very small, which is to be expected in view of the low frequency of occurrence.

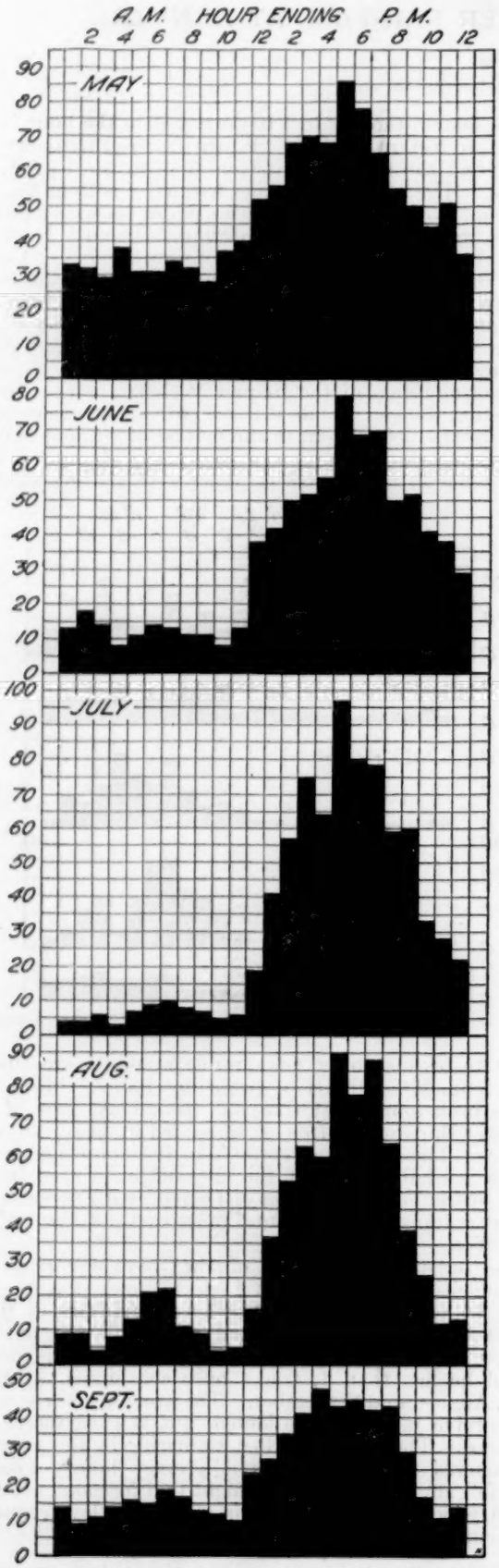

FIGURE 2.—Frequency of occurrence of a trace of precipitation. Figures indicate the total number of times that a trace occurred during each hour for the period 1919 to 1938, inclusive.

During the 20 years under consideration there were 1 May, 3 Junes, 10 Julys, 6 Augusts, and 5 Septembers when no measurable rain was recorded between midnight and noon. In the same 12-hour interval the total fall for the month exceeded 0.25 inch only 17 times in May, 5 times in June, 4 times in July, 4 times in August, and 7 times in September. If we divide the day into two 12-hour periods it is found that 62 percent of the summer rainfall occurs in the daytime interval or between 8 a. m. and 8 p. m. However, if we take the 8 hours of maximum rainfall, or from 1 p. m. to 9 p. m. we find that 47 percent

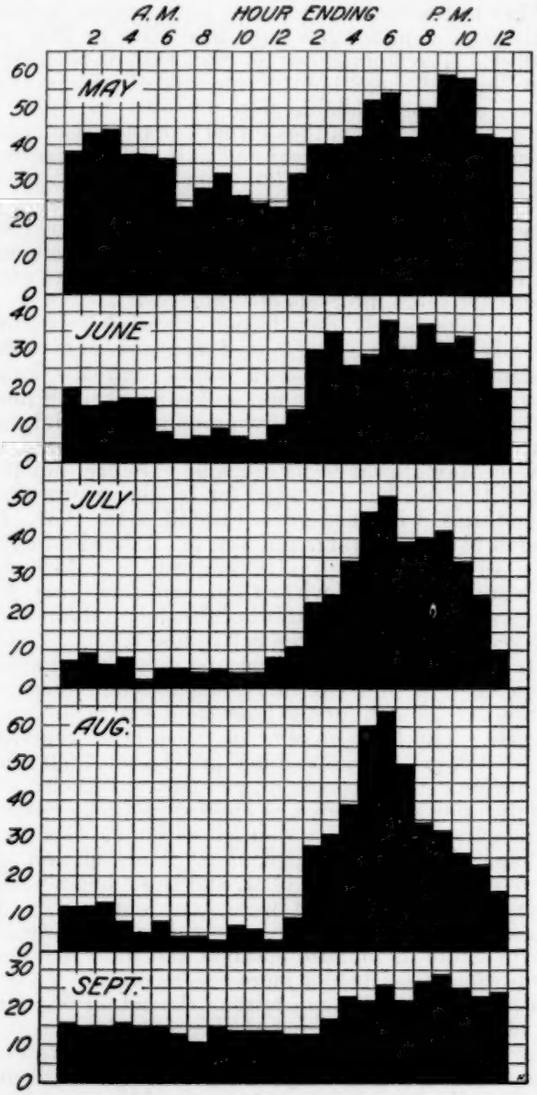

FIGURE 3.—Frequency of occurrence of 0.01 inch or more. Figures indicate the total number of times that 0.01 inch or more has occurred during each hour in the period 1919 to 1938, inclusive.

of the rain occurs in this period in May, 52 percent in June, 73 percent in July, 75 percent in August and 44 percent in September. The average for the entire 5 months is 51 percent.

Although rains of 1 inch per hour have been recorded during the period under discussion, they are not at all common. This will be seen from an examination of the data. During the 20 years covered in this study rains of 1 inch or more in 1 clock hour occurred twice in May, twice in July and three times in August. These numbers would be increased somewhat if rains of 1 inch or more per

hour were considered without reference to the clock hours. Considering the total fall for the day, it was found that surprisingly few days have had a total of 1 inch or more of rain. There were 5 days in May, 5 in June, 2 in July, 4 in August, and 3 in September, when the total fall for the day was in excess of 1 inch. This makes a total of only 17 days in 20 years when a rainfall of 1 inch or more was recorded. The chances of 1 inch of rain on any 1 day are small, indeed, or 17 in 3,060. This amounts to 1 day in 180 or less than 1 per summer.

The heaviest fall in any 1 hour was 1.72 inches for the hour 7 p. m. to 8 p. m. July 31, 1919; and the heaviest fall for any 1 day was 2.93 inches on August 23, 1921.

It seems that the greater amounts of precipitation in the afternoon is directly associated with the daily thunderstorm distribution. Thunderstorm activity is usually not very well marked in May until after the middle of the month, and this may be a contributing factor in the more evenly distributed hourly rainfall values. The reverse situation occurs in September. Thunderstorm frequency wanes rapidly after the middle of the month, and this also contributes to a more uniform variation in hourly rainfall.

A graph was prepared, figure 4, to show the diurnal distribution of thunderstorms. Only the hour during which the thunderstorm began was used, hence no thunderstorm is recorded in more than 1 hour. Thunderstorms at Denver are usually of short duration and it is not often that one lasts longer than 2 hours. Most are terminated within 1 hour after beginning.

The close resemblance in the curves of figure 4 to those for the corresponding months in figures 2 and 3 is most striking. The paucity of thunderstorms between 10 p. m. and noon and the high concentration in the afternoon seem to justify the statement that the rainfall distribution is closely associated with the diurnal variation of thunderstorms.

A further examination of the rainfall and thunderstorm data was made, and it was found that during May 44 percent of the precipitation fell in connection with thunderstorms. The percentages for June, July, August, and September are 75, 90, 87, and 37, respectively. In making this compilation all the rain on any day during which a thunderstorm occurred was used, whether it fell in connection with the thunderstorm or at some other time during the day. It is believed that there is justification for this, because if a thunderstorm occurred at any time during the day it would indicate that an unstable condition existed. Any rain falling during such an unstable condition would be of thundershower type.

At Denver the average number of thunderstorms in May is 8; in June, 13; in July, 14; in August, 15; and in September, 5. These storms are of such frequent occurrence at Denver, even more frequent in the neighboring mountains, that the public accepts them as commonplace. However, to the meteorologist they are of more than passing interest. Studies of the causes, indications, and forecasting of the thunderstorms have been made. While conclusive observational material is not available at the present time, the results of these preliminary studies seem to indicate that the thunderstorms are local in character and influenced chiefly by the physical features surrounding Denver.

Denver is situated in the Great Plains about 40 miles east of the main range of the Rockies, whose average altitude is in excess of 10,000 feet, and about 15 miles east of the foothills. About 40 miles south of Denver is an east-west connecting spur known as the Palmer Lake Divide. It has an altitude of about 7,300 feet. Denver is about 5,280 feet above sea level and located near the southwest corner of the "pocket" formed by the main range and the spur.

Except during periods of active cyclonic storms the nighttime wind at Denver is light and parallels the main mountain range. Under such conditions the wind may be classed as a drainage wind and is predominatnly from the south. The eastward face of the Rockies presents a surface nearly normal to the first rays of the summer sun. In response to the greater heating there than over the level plains there is soon a flow of air up the mountain side and the wind at Denver shifts rapidly after sunrise from southerly to easterly and finally to a northeasterly

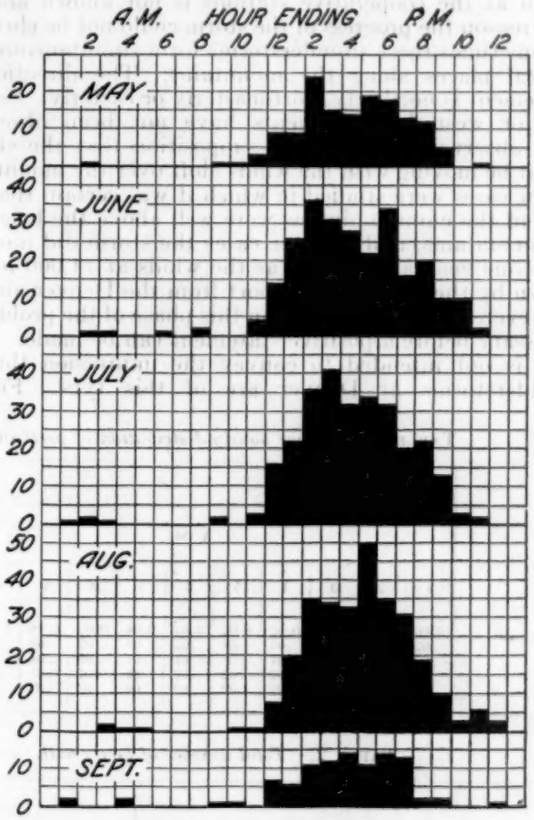

FIGURE 4.—Diurnal distribution of thunderstorms at Denver, Colo. The figures indicate the total number of storms for each hour, 1919 to 1938, inclusive.

direction. Despite the fact that Denver is nearly 40 miles from the mountains this shift in wind is pronounced and the easterly winds usually have velocities of 10 miles per hour or more. As the morning progresses, the flow of air toward the mountains becomes stronger; and if there is sufficient moisture in the atmosphere cumulus clouds soon begin to appear along the mountains southwest of Denver. The first cumuli are usually visible before 10 a. m. By noon the cumuli have grown into towering cumulo-nimbus clouds whose tops extend above the mountains. The fully developed thunderstorms then move out over the plains. However, they soon dissipate and it is not often that they are of any importance after they have traveled 75 miles from the point of origin.

One of these typical storms, on June 22, 1938, was studied in some detail. Rainfall records from cooperative stations were examined and it was found that 0.98 inch of rain fell at Bailey, about 30 miles south-southwest of

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Denver. The fall at Denver was 0.28 inch. Stations west of Denver and north of Bailey reported falls ranging from 0.05 to 0.35 inch. There was only a trace at Greeley, 40 miles north-northeast of Denver. No rain was recorded south of the Palmer Lake Divide and the only station east of Denver reporting rain was Byers, about 30 miles, air line, and the amount was only 0.02 inch. In this case the storm appeared to move almost due north of the place of formation, near Bailey, with rain along its path and east of the Rockies. The storm dissipated north of Fort Collins, or about 80 miles from its source. No rain was recorded north of Fort Collins, but the fall there was 0.30 inch. The time of occurrence of the thunderstorm at the cooperative stations is not known and for that reason the progress of the storm could not be checked.

Sometimes these thunderstorms form simultaneously at several places along the mountains. The direction of movement is northerly, northeasterly or easterly. Southerly or westerly movements have not been observed. This observation led to the supposition that the storms might be moving with the winds aloft over the mountains. A few cases were studied in which it was certain that the tops of the cumulo-nimbus were well above the height of the mountains, and in these cases the storm did move in the same general direction as the winds at 14,000 feet as shown by the winds-aloft report from the Denver airport. However, much more study on this phase of the problem is necessary before a positive statement can be made.

It is not intended to convey the impression that all thunderstorms at Denver are of this type. Frontal thunderstorms do occur, but it is recognized that the action along cold fronts in summer is not strong during the night because of the ground inversions that are so common. However, during the day thunderstorm activity along even weak fronts may be greatly accentuated. Furthermore, it is believed that many of the thunderstorms that occur after sunset are simply the aftermath of storms that were initiated during the day, but did not develop as rapidly as usual.

SUMMARY

In this paper statistical data covering amounts and frequency of rainfall at Denver during the 5 summer months, May to September, inclusive, for the 20 years 1919 to 1938, inclusive, are presented. These data show a high concentration of rainfall amounts and the highest frequencies in the afternoon and early evening with almost negligible amounts between midnight and noon, especially in June, July, and August. Thunderstorm data for the same period are presented and a close correlation between diurnal thunderstorm variation and daily rainfall variation exists. It is concluded that the thunderstorms are the prime factor in summer rainfall distribution at Denver.

The paper by Alexander [1] has an excellent bibliography on this subject, but to be complete the discussion of San Francisco rainfall by Counts [2] should be added to it.

[1] Alexander, H. F. A Study of the Hourly Precipitation at Oklahoma City, Okl., Monthly Weather Review, 1938, 66: 126–128.
[2] Counts, R. Corday, Jr. Hourly Frequency and Intensity of Rainfall at San Francisco, Calif. Monthly Weather Review, 1933, 61: 225–228.

TABLE 1.—*Average hourly distribution of precipitation at Denver, Colo., for the 20-year period, 1919–38, inclusive*

	Hour ending—																							
	A. M.											Noon	P. M.											Midnight
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
May	0.06	0.08	0.07	0.05	0.06	0.05	0.04	0.05	0.06	0.06	0.05	0.06	0.10	0.07	0.12	0.08	0.17	0.08	0.08	0.10	0.21	0.11	0.07	0.07
June	.02	.04	.03	.03	.03	.02	.02	.02	.03	.04	.05	.05	.03	.11	.08	.08	.08	.08	.06	.10	.06	.06	.07	.06
July	.03	.02	.02	.01	T	.01	.01	.01	.01	T	.02	.02	.05	.07	.06	.10	.19	.13	.15	.21	.12	.07	.09	.02
Aug	.04	.02	.01	.02	.02	.02	.01	.01	.01	.02	.01	T	.04	.11	.14	.17	.26	.25	.14	.05	.15	.11	.05	.03
Sept	.02	.06	.03	.02	.02	.02	.02	.03	.03	.03	.02	.03	.02	.03	.03	.03	.07	.07	.06	.06	.08	.07	.06	.06

TABLE 2.—*Total number of hours with rain at Denver, Colo., for the 20-year period, 1919–38, inclusive*

		Hour ending—																							
		A. M.											Noon	P. M.											Midnight
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
May	Traces	33	32	29	38	31	31	34	32	38	37	40	52	56	68	70	68	86	78	65	55	50	44	51	36
	0.01 or more	38	43	44	37	37	36	23	28	32	26	24	23	32	40	40	42	52	54	42	50	59	57	43	42
	Total	71	75	73	75	68	67	57	60	70	63	64	75	88	108	110	110	138	132	107	105	109	101	94	78
June	Traces	13	18	14	8	11	14	13	11	11	8	13	38	42	50	52	57	80	69	70	59	52	41	38	29
	0.01 or more	20	15	16	12	12	8	6	8	9	7	6	10	14	30	35	26	29	38	30	37	32	34	28	20
	Total	33	33	30	20	23	22	19	19	20	15	19	48	56	80	87	83	109	107	100	87	84	75	66	49
July	Traces	4	4	6	3	7	9	10	8	7	5	6	19	41	57	75	64	97	80	78	59	60	33	28	22
	0.01 or more	7	9	6	8	2	5	5	4	5	4	4	8	11	23	25	34	47	51	39	40	42	34	25	10
	Total	11	13	12	11	9	14	15	12	12	9	10	27	52	80	100	98	144	131	117	99	102	67	53	32
August	Traces	9	9	4	8	13	21	22	11	9	4	5	16	37	53	63	60	90	78	88	64	39	26	12	13
	0.01 or more	12	12	12	8	5	8	4	4	3	7	6	3	9	28	31	39	60	64	50	34	32	26	23	16
	Total	21	21	16	16	18	29	26	15	12	11	11	19	46	81	94	99	150	142	138	98	71	52	35	29
September	Traces	14	9	11	14	16	15	19	17	13	12	10	24	13	13	17	23	22	26	22	27	29	25	23	24
	0.01 or more	16	15	15	16	15	15	13	11	15	14	14	14	28	35	41	48	43	45	42	43	30	17	11	14
	Total	30	24	26	30	31	30	32	28	28	26	24	38	41	48	58	71	65	71	64	70	59	42	34	38

AIRPORT AND CITY TEMPERATURES AT DETROIT, MICH.

By CLARENCE J. ROOT

[Weather Bureau Office, Detroit, Mich., November 1938]

At a number of places telegraphic observations and the official city records have been moved from the downtown office to the airport station. The first move of this kind was made at Detroit. Observations are being continued at the City Office in downtown Detroit to supplement those made at the airport.

The instrument shelter at the City Office is on the roof of the Federal building, a 10-story structure located in the business section. Detroit City Airport, on the other hand, is 5 miles northeast of the Federal building; it is surrounded by residential sections, with some industrial and commercial properties. In general, the residential areas, largely built-up, extend for some miles beyond. The instrument shelter has a ground exposure and is located at the south edge of the airport property adjacent to a cemetery.

There are now available for comparison 5 years of record for the months of June to September, inclusive, and 4 years for the other months. In the averages discussed in this study the airport is considered as a base and the City Office values as plus or minus.

The maximum temperature averages lower at the City Office for all months except June; the departures range from −1.0° in October to 0.0° in June. December and January are more than −0.7° and March, May, and July less than −0.3°.

Minimum averages are higher at the City Office, the differences vary from +0.5° in November to +2.8° in in July. Every month from May to October, inclusive, shows a difference of more than 2°.

The average mean temperatures show departures which range from −0.1° in November to +1.3° in July.

Taking an average of the absolute highest by individual months, the values differ by −2° for 5 months, −1° for 2 months, and 0° for 2 months. Similarly, the values for the absolute lowest vary from 0° to +4°.

By seasons, summer shows the smallest difference for the mean maximum (−0.2°) but the greatest for the mean minimum (+2.6°). The mean maximum has the greatest difference in autumn (−0.8°), and the mean minimum the least in winter (+1.3°).

Data for the 52 months indicate that on the average the maximum at the downtown office is 0.5° lower than at the airport, the minimum 1.8° higher, and the mean 0.6° higher.

Table showing difference in temperature between airport and city office, Detroit, Mich.

[Airport considered as base; city office plus or minus]

Data	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average maximum	−0.8	−0.3	−0.1	−0.6	−0.2	0.0	−0.2	−0.3	−0.7	−1.0	−0.7	−0.8	−0.5
Average minimum	+1.1	+1.5	+1.1	+1.2	+2.1	+2.5	+2.8	+2.6	+2.7	+2.2	+0.5	+1.4	+1.8
Average mean	+0.2	+0.6	+0.5	+0.3	+1.0	+1.2	+1.3	+1.2	+1.0	+0.6	−0.1	+0.3	+0.6
Average absolute highest	−2	−2	−1	0	0	0	−1	0	−2	−2	−2	0	−1
Average absolute lowest	+4	+2	+2	0	+2	+3	+3	+3	+3	+3	0	+1	+2
Greatest difference of any month—absolute highest	−4	−2	−3	{ +1 −1 }	+1	−2	−2	−1	−3	−5	−3	+3	−5
Greatest difference of any month—absolute lowest	+8	+6	+10	+2	+4	+5	+5	+6	+4	+4	+2	+2	+10

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(1) Abbe, Cleveland: Thermometer Exposure. 25: 306–7, July 1897.
(2) Henry, A. J.: Comparative Thermometer Readings at New York. 28: 99–100, March 1900.
(3) Hammon, W. H., Duenckel, F. W.: Abstract of a Comparison of the Minimum Temperatures Recorded at the United States Weather Bureau and the Forest Park Meteorological observatories, St. Louis, Mo. for the year 1901. 30: 12–13, January 1902.
(4) Smith, J. W.: The climate of the City and the Country Compared. 40: 30–31, January 1912.
(5) Coberly, E. D.: City and Suburban Temperatures. 40: 573–4, April 1912.
(6) Köppen, V.: A Uniform Thermometer Exposure at Meteorological Stations for Determing Air Temperature and Atmospheric Humidty. 43: 389–395, August 1915.
(7) Redway, J. W.: Urban versus Suburban Temperatures. 47: 28–29, January 1919.
(8) Young, F. D.: Influence of Exposure on Temperature Observations. 48: 709–711, December 1920.
(9) Alciatore, H. F.: Effect of Change of Position of the Thermometer Shelter at Escondido, Calif., upon the Minimum Temperature. 49: 339–340, June 1921.
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(11) Laskowski, B. R.: Ground Temperatures Compared to Roof Temperatures. 64: 17, January 1936.
(12) Robb, A. D.: Comparison of Temperatures from Roof and Ground Exposures at Topeka, Kans., 1935–36. 65: 388–392, November 1937.

COMPUTATION OF DEPTH OF PRECIPITABLE WATER IN A COLUMN OF AIR

By SAMUEL B. SOLOT

[Weather Bureau, Washington, D. C., December 1938]

It has been found that one of the most significant quantities in hydrometeorological studies is Wp, the depth of precipitable water in a column of air. After some experimentation, the following simple tabular method of computing the value of Wp from aerological observations was developed for use in the Hydrometeorological Research Section.

Let M_w = total mass of water vapor,
h = height,
ρ_w = density of water vapor,
ρ = density of air,
g = acceleration of gravity,
q = specific humidity,
P = pressure in mb,
Wp = depth of precipitable water (inches).

For a column of water vapor with the horizontal cross-section considered as unity:

$$dM_w = \rho_w dh \tag{1}$$

$$M_w = \int_0^h \rho_w dh \tag{2}$$

$$dp = -\rho g dh \tag{3}$$

combining (2) and (3)

$$M_w = -\int_{P_1}^{P_h} \frac{\rho_w dp}{\rho g} \tag{4}$$

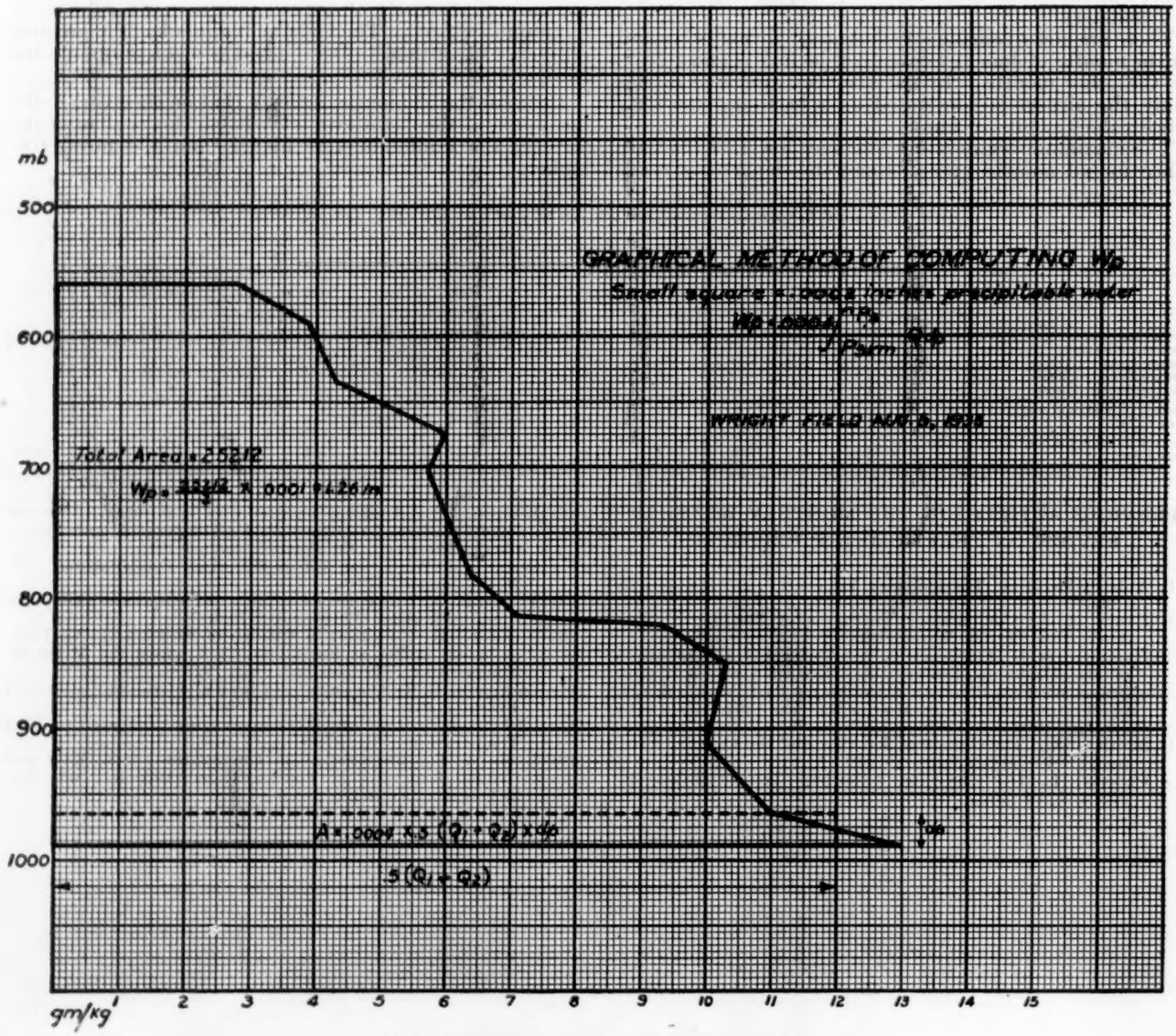

FIGURE 1.—Graphical method of computing precipitable water.

g can be considered a constant with negligible error.

$$M_w=-\frac{1}{g}\int_{P_0}^{P_4}\frac{\rho_w dp}{\rho} \tag{5}$$

since $q=\frac{\rho_w}{\rho}$

$$M_w=-\frac{1}{g}\int_{P_0}^{P_4}q dp \tag{6}$$

Reversing direction of integrations

$$M_w=\frac{1}{g}\int_{P_0}^{P_0}q dp \tag{7}$$

Figure 2.

COMPUTATION OF DEPTH OF PRECIPITABLE WATER

Station Wright Field (Ohio) Elevation ____ Computed by GMC Date December 2, 1938.

Date of Observation August 5, 1935. Checked by JHR Date December 2, 1938.

Type of Instrument Aerometeorograph File No. 23508

Levels Sfc.	e	P	q	dp	Q2m	A	dw_p
		989	13.0				
1.		965	11.0	24	24.0	576	
2.		911	10.0	54	21.0	1134	
3.		851	10.3	60	20.3	1218	
4.		824	9.3	27	19.6	529	
5.		814	7.1	10	16.4	164	
6.		776	6.3	38	13.4	509	
7.		705	5.7	71	12.0	852	
8.		675	6.0	30	11.7	351	
9.		633	4.3	42	10.3	433	
10.		592	3.9	41	8.2	336	
11.		562	2.8	30	6.7	201	
12.							
13.							
14.							
15.							
16.							
17.							
18.							
19.							
20.							
					Total	6303	1.26

e = vapor pressure in mb. dp = P_1 minus P_2, etc.

P = pressure in mb. Q_{2m} = q_1 + q_2, etc.

q = specific humidity g/kg. A = Qdp

0.0002 A = W_p, depth in inches of precipitable water.

Dimensional formulas may be expressed as follows:

q=non-dimensional ration.

$$P=\frac{ML}{L^2T^2}.$$

$$g=\frac{L}{T^2}.$$

$$\frac{Pq}{g}=\frac{MLT^2}{L^2T^2}=\frac{M}{L^2}.$$

In the C. G. S. system this could be expressed as $\frac{gm}{cm^2}$. Since 1 cc. of water has a mass of 1 gram this becomes $\frac{cm^3}{cm^2}$ or cm. In order to evaluate the constant which would make the result expressible in inches of precipitable water, the following substitutions must be made:

g=980 cm/sec^2.

1 mb=1,000 $\frac{dynes}{cm^2}$.

1 inch=2.54 cm.

1 gm./kg. $=\frac{1}{1000}$ gms./gm.

$$\frac{1000}{980\times2.54\times1000}=.0004.$$

Figure 3

COMPUTATION OF DEPTH OF PRECIPITABLE WATER

Station Murfreesboro (Tennessee) Elevation 174 M. Computed by GMC Date December 6, 1938.

Date of Observation May 25, 1935 Checked by JHR Date December 8, 1938.

Type of Instrument ____ File No. ____

	Levels Sfc.	e	P 1000	q	dp	Q2m	A	dw_p
		9.0		8.6				
800 M.	1.	7.9	964	8.1	36	10.7		.077
1000 M.	2.	6.4	907	4.4	57	9.8		.108
1500 M.	3.	5.2	850	3.8	57	8.2		.093
2000 M.	4.	4.0	799	3.1	51	6.9		.084
2500 M.	5.	2.4	752	2.0	47	5.1		.048
3000 M.	6.	1.9	706	1.7	46	3.7		.034
4000 M.	7.	0.9	621	0.9	85	2.6		.044
5000 M.	8.	0.6	547	0.7	74	1.6		.024
	9.							
	10.							
	11.							
	12.							
	13.							
	14.							
	15.							
	16.							
	17.							
	18.							
	19.							
	20.							
						Total		.51

e = vapor pressure in mb. dp = P_1 minus P_2, etc.

P = pressure in mb. Q_{2m} = q_1 + q_2, etc.

q = specific humidity g/kg. A = Qdp

0.0002 A = W_p, depth in inches of precipitable water.

Therefore $Wp=.0004\ q\ dp$ inches.

where q is expressed in gm./kg.

and dp in millibars.

Furthermore, it has been found that for practical purposes the precipitable water present from the surface to 5 kilometers above sea level may be considered as equal to the total amount of precipitable water, since the amount above that elevation is very small.

Thus $$Wp=.0004\int_{P_{5m}}^{P_s} q\ dp \tag{8}$$

It is possible to approximate the value of the above integral graphically by plotting significant values for q against P on linear cross section paper and computing the area under the curve.

To illustrate, the following data for Wright Field, Dayton, Ohio, August 5, 1935, were thus plotted (fig. 1).

P	q
989	13.0
965	11.0
911	10.0
851	10.3
824	9.3
814	7.1
776	6.3
705	5.7
675	6.0
633	4.3
592	3.9
562	2.8

P_n, P_{n-1}=pressure at any significant level and pressure at next lower significant level, respectively.

Q_n, Q_{n-1}=specific humidity at P_n and P_{n-1}, respectively.

From figure 1 it will readily be seen that the value of $A_{n,\,n-1}$, is equivalent to the area of a rectangle whose sides are

$$P_{n-1}-P_n \text{ and } .5(Q_{n-1}+Q_n)$$

$$A_{n,\,n-1}=.5(P_{n-1}-P_n)(Q_{n-1}+Q_n)$$

and $$Wp_{n,\,n-1}=.5\times.0004(P_{n-1}-P_n)(Q_{n-1}+Q_n)$$

$$=.0002(P_{n-1}-P_n)(Q_{n-1}+Q_n)$$

and $$Wp \quad =\sum .0002\ (P_{n-1}-P_n)(Q_{n-1}+Q_n)$$

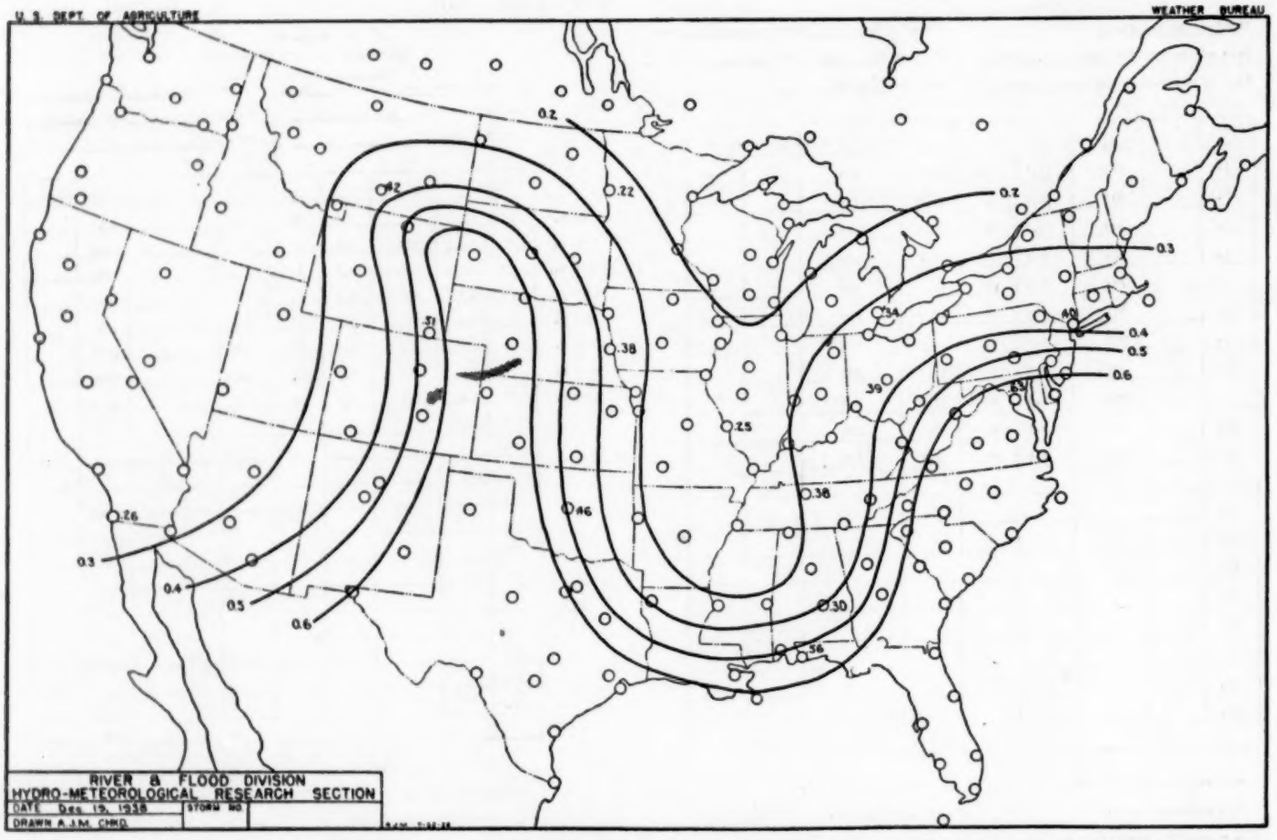

FIGURE 4.—Distribution of precipitable water from 2 to 5 kilometers on the morning of May 31, 1935, during the intense rain which caused the Republican River flood. Shaded portion shows the area of flood rains.

The scale in figure 1 was chosen for convenience. Since one small scalar element equals 0.1 gm./kg. and 5 millibars, it will be seen that one small square of area is equivalent to ½ equation units. Thus if A_t represents the total number of small squares, then

$$\frac{.5\times4}{10{,}000}A_t=\text{inches precipitable water,}$$

or

$$\frac{.0004}{2}A_t=\text{inches precipitable water.}$$

Let $A_{n,n-1}$=an area on the graph between any two significant pressures expressed in equation units. (p=1 *mb.*, q=1 gm./kg.).

If, instead of being plotted, the data were entered on a suitable form, the result is obtainable by means of very simple calculations. Figure 2 shows such a form.

In column P are entered pressures at significant levels. In column Q, specific humidities for corresponding levels. In column dp are the successive values for $P_{n-1}-P_n$. In column Q_{2m} are the successive values for $Q_{n-1}+Q_n$. Column A is the product of dp and Q_{2m}. The final result is the sum of column A multiplied by the constant .0002.

In some cases the values of Wp between various standard elevations are required. For this purpose it is more convenient to use standard level data from Weather Bureau Form 1109, instead of significant level data. The error involved in using standard level data is very small.

For this purpose column dWp has been provided. This column is simply the product of A and the constant .0002. In actual practice it is unnecessary to use both column A and dWp together, since dWp may be entered directly by multiplying dp by twice column Q_{2m} and setting decimal places properly. Three decimal places are sufficient. Column dWp may then be summed up and the third decimal place dropped. This will give Wp directly (fig. 3).

Column e is provided for cases where specific humidity is not given, but must be computed from vapor pressure, e.

It is not the purpose of this article to discuss the use of the quantity Wp. However, a chart showing the daily distribution of precipitable water from 2 to 5 kilometers over the United States is herein presented for general interest.

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By AMY P. LESHER

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SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, APRIL, 1939

By IRVING F. HAND

Measurements of solar radiant energy received at the surface of the earth are made at eight stations maintained by the Weather Bureau, and at nine cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory of Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data, obtained up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parenthesis). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian silver disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 8 a. m. (75th meridian time) and at noon (local mean solar time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, their departures from normal, and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

Direct radiation intensities averaged above normal for April at all Weather Bureau stations.

Total solar and sky radiation was above normal at all stations with the exception of Madison, New York, La Jolla, Miami, Riverside, Ithaca, Newport, Fairbanks, and Blue Hill.

Polarization measurements made on 5 days at Madison give a mean of 55 percent with a maximum of 61 percent on the 30th. Both of these values are close to the corresponding normals for April.

TABLE 1.—*Solar radiation intensities during April 1939*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
April 4	2.74	.....	0.83	1.00	1.21	.....	.....	.....	.....	.....	2.49
April 5	3.30	.....	.93	1.05	1.26	1.49	.....	.....	.....	.....	3.30
April 7	2.74	.....	.....	1.00	1.16	1.39	.....	.....	.....	.....	2.87
April 10	5.56	.....	.....	.....	.99	.....	.....	.....	.....	.....	7.57
April 12	5.16	0.60	.78	.94	1.11	.....	.....	.....	.....	.....	3.45
April 14	3.45	.68	.75	.81	1.01	.....	.....	.....	.....	.....	3.81
April 20	4.95	.95	1.01	1.06	1.18	.....	.....	.....	.....	.....	4.75
April 21	8.18	.....	.....	.....	1.08	.....	.....	.....	.....	.....	6.50
April 22	5.79	.....	.87	.95	1.13	.....	.....	.....	.....	.....	4.95
Means	.....	.74	.86	.97	1.13	(1.44)	.....	.....	.....	.....	.....
Departures	.....	+.04	+.07	+.08	+.05	+.07	.....	.....	.....	.....	.....
MADISON, WIS.											
April 3	3.45	.....	.....	.....	1.24	1.45	.....	.....	.....	.....	3.63
April 4	3.63	0.70	0.86	1.04	1.20	1.54	.....	.....	.....	.....	3.15
April 8	2.36	.88	1.08	1.15	.....	.....	.....	.....	.....	.....	3.00
April 12	1.88	.....	1.16	1.26	1.46	.....	.....	.....	.....	.....	1.88
April 13	2.26	.....	.90	1.05	1.20	1.44	.....	.....	.....	.....	3.00
April 22	3.99	.....	.94	1.07	1.22	1.42	.....	.....	.....	.....	4.57
April 29	5.36	.....	.....	1.17	1.39	1.53	.....	.....	.....	.....	3.30
Means	.....	(.79)	.95	1.14	1.31	1.48	.....	.....	.....	.....	.....
Departures	.....	−.03	+.01	+.09	+.10	+.04	.....	.....	.....	.....	.....
LINCOLN, NEBR.											
April 6	2.36	.....	.....	.....	1.45	.....	.....	.....	.....	.....	1.60
April 7	2.74	.....	.....	.....	1.29	1.60	.....	.....	.....	.....	2.74
April 8	3.15	.....	0.88	1.08	1.29	1.61	.....	.....	.....	.....	3.00
April 11	4.95	.....	.....	.....	.....	.....	1.30	1.12	0.95	0.85	1.32
April 12	2.26	0.72	.79	.92	1.34	.....	.....	.....	.....	.....	1.96
April 19	4.37	.....	.85	1.01	1.21	.....	1.25	.....	.....	.....	4.17
April 21	4.75	.....	.97	1.13	1.35	1.55	1.31	1.09	.94	.78	3.81
April 22	5.36	.....	.72	.89	1.14	.....	.....	.....	.....	.....	6.76
April 25	8.18	.....	.84	1.02	1.18	.....	.....	.....	.....	.....	7.87
April 27	7.04	.....	.90	1.06	1.21	1.44	1.17	.95	.76	.65	4.75
April 28	6.02	.....	.81	.91	1.14	.....	.....	.....	.....	.....	7.24
April 29	6.27	.....	.....	.79	1.16	.....	.....	.....	.....	.....	6.50
Means	.....	(.72)	.83	.99	1.25	1.55	1.26	1.05	.88	.76	.....
Departures	.....	.00	.00	+.02	+.06	+.09	+.08	+.09	+.06	+.07	.....

*Extrapolated.

TABLE 1.—*Solar radiation intensities during April 1939*—Continued

[Gram-calories per minute per square centimeter of normal surface]

BLUE HILL, MASS.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
April 3	2.9	.....	.....	.....	1.14	.....	.....	.....	.....	.....	2.9
April 5	3.0	.....	.....	1.11	1.26	.....	.....	0.92	0.88	0.83	3.2
April 7	5.6	.....	.....	.....	.....	1.42	1.24	1.08	.94	.82	3.7
April 9	3.1	.....	.....	.....	.....	.....	.....	1.06	.91	.81	4.2
April 13	2.6	.....	.....	.....	.....	.....	1.25	1.03	.87	.78	3.1
April 14	3.1	.....	.....	.....	1.20	.....	.....	.....	.....	.....	3.6
April 20	5.5	.....	.....	.....	.....	1.26	.....	.....	.....	.....	5.3
April 21	4.9	.....	.....	.....	.94	1.20	.95	.73	.55	.46	5.4
April 23	5.5	.....	.....	.....	1.12	1.31	.....	.....	.....	.....	6.5
April 25	6.1	.....	.....	.....	.....	.97	.62	.43	.29	.17	6.3
Means	.....	.....	.....	1.11	1.13	1.23	1.02	.88	.74	.65	.....
Departures	.....	.....	.....	+.01	−.06	+.15	−.10	−.12	−.14	−.08	.....
LATE REPORT—DURING MARCH 1939											
March 1	5.4	.....	.....	0.74	.....	.....	.....	.....	.....	.....	3.8
March 2	2.0	.....	.....	.....	.....	1.44	1.40	1.23	1.11	1.02	2.2
March 3	1.4	0.99	1.10	1.22	.....	.....	1.29	1.08	.95	.77	1.9
March 7	2.6	.88	.....	.....	.....	.....	.....	.....	.....	.....	2.5
March 8	1.1	.....	.....	1.20	1.36	1.51	.....	.....	.94	.82	1.9
March 10	2.3	.....	.....	.....	.....	.....	.....	.....	.....	.72	2.4
March 14	2.2	.88	.96	1.14	1.29	1.55	1.29	1.12	1.03	.88	2.5
March 17	1.9	.86	.....	1.07	1.18	.....	.....	.....	.....	.....	3.2
March 18	1.4	.....	.....	.....	1.05	.....	.....	.....	.....	.....	1.7
March 19	1.4	.....	.....	.....	.....	1.48	1.20	.98	.88	.77	1.2
March 21	2.0	.....	.....	.....	1.09	1.30	1.06	.88	.72	.62	2.0
March 22	1.4	.....	.....	1.12	1.30	1.49	1.31	1.11	1.04	1.02	1.4
March 23	1.3	.....	1.06	1.19	1.29	1.51	.....	.....	.....	.....	1.5
March 24	3.4	.....	.....	.89	1.04	.....	.....	.....	.....	.....	4.1
March 29	2.6	.....	.....	.....	1.29	1.60	1.31	1.05	.94	.83	3.2
Means	.....	.90	1.04	1.07	1.21	1.49	1.27	1.07	.95	.83	.....
Departures	.....	+.04	+.10	−.01	−.01	+.07	+.06	+.02	0	−.02	.....

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

[Gram-calories per square centimeter]

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca	Newport
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
April 2	505	392	434	372	325	559	364	505	450	428	457	467	338	625	415	194	368
April 9	510	337	366	283	392	568	272	386	413	498	467	408	358	720	365	176	387
April 16	435	250	391	225	313	556	275	543	405	465	470	552	413	680	544	206	439
April 23	348	554	605	460	296	626	399	473	507	491	406	460	303	639	439	253	336
DEPARTURES FROM WEEKLY NORMALS																	
April 2	+138	+22	+25	+82	+6	+40	+27	+68	−52	−33	+77	−25	−28	+32	+87	−44	−24
April 9	+133	−65	−76	−61	+65	−5	−91	−72	−59	+25	+64	−71	+13	+92	+56	−77	−36
April 16	+13	−144	−60	−109	−51	−40	−99	+63	−68	−12	+49	+23	+18	+41	+106	−61	−4
April 23	−98	+121	+159	+99	−115	+50	−10	−29	−14	+11	+12	−23	−144	+17	−62	−161	−158
ACCUMULATED DEPARTURES ON APRIL 29																	
	+3,115	+952	+532	+2,758	−504	−714	−1,379	−763	+1,400	+1,603	+5,355	−1,491	−1,393	+5,214	+2,898	−4,697	−1,960

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.) Superintendent, U. S. Naval Observatory. Data from measurements at the U. S. Naval Observatory from plates obtained at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millionths of Sun's visible hemisphere. For each day, below longitude, latitude, area of spot or group, and spot count, are given respectively the assumed longitude of the center of the disk, assumed latitude of the center of the disk, total area of spots and groups, and total spot count]

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1939	h m		°	°	°	°				
Apr. 1	10 49	6377	−64	139	−10	64	73	3	F	U. S. Naval.
		6373	−39	164	+11	43	194	25		
		6374	+19	222	−15	21	36	4		
		6372	+20	223	+6	24	12	1		
				(203)	(−7)		315	33		
Apr. 2	11 30	6379	−70	119	−20	68	36	1	P	Do.
		6378	−69	120	−12	68	48	3		
		6377	−50	139	−9	50	194	5		
		6373	−24	165	+11	29	291	28		
		6376	−4	185	−12	7	73	7		
		6374	+33	222	−13	34	12	1		
		6372	+35	224	+6	37	145	8		
				(189)	(−6)		799	53		
Apr. 3	11 30	6379	−59	117	−20	59	48	5	F	Do.
		°	−58	118	+12	60	6	2		
		6378	−57	119	−13	57	36	1		
		6377	−37	139	−9	37	339	15		
		6373	−12	164	+11	20	291	19		
		6376	+9	185	−11	11	48	8		
		6374	+47	223	−12	47	24	1		
		6372	+48	224	+7	50	97	3		
				(176)	(−6)		889	54		
Apr. 4	11 20	6380	−80	83	−12	80	97	1	P	Do.
		6379	−45	118	−19	46	36	3		
		6378	−43	120	−12	43	24	1		
		6377	−23	140	−9	23	315	12		
		6373	+3	166	+12	17	291	19		
		6372	+63	226	+7	65	61	3		
				(163)	(−6)		824	39		
Apr. 5	11 16	6380	−69	81	−12	69	97	6	G	Do.
		6379	−32	118	−20	35	48	7		
		6378	−30	120	−12	31	24	1		
		6377	−9	141	−9	10	436	25		
		6373	+17	167	+12	25	339	35		
		6372	+76	226	+7	77	6	2		
		6374	+77	227	−12	77	6	1		
				(150)	(−6)		956	77		
Apr. 6	10 58	6381	−80	57	−10	80	145	1	P	Mt. Wilson.
		6380	−57	80	−11	57	97	3		
		6379	−19	118	−19	24	48	2		
		6378	−17	120	−12	18	24	1		
		6377	+5	142	−9	6	388	10		
		6373	+34	171	+11	38	339	15		
				(137)	(−6)		1,041	32		
Apr. 7	11 5	6384	−81	43	−18	81	194	1	F	U. S. Naval.
		6381	−66	58	−11	65	194	1		
		6383	−58	66	+24	65	97	7		
		6380	−43	81	−11	43	85	5		
		6382	−42	82	−9	42	6	1		
		6379	−7	117	−20	16	24	5		
		6377	+17	141	−9	18	339	11		
		6373	+46	170	+11	50	291	18		
				(124)	(−6)		1,230	40		
Apr. 8	12 35	6385	−80	29	+23	84	97	1	P	Do.
		6384	−69	40	−17	68	194	1		
		6381	−52	57	−11	52	242	1		
		6383	−44	65	+23	51	170	12		
		6380	−28	81	−11	29	48	3		
		6382	−27	82	−9	27	6	1		
		6377	+31	140	−9	31	461	28		
		6373	+64	173	+13	67	145	7		
				(109)	(−6)		1,363	54		
Apr. 9	11 17	6386	−82	15	+10	83	145	4	G	Do.
		6385	−65	32	+22	70	145	1		
		6384	−57	40	−17	57	206	1		
		6381	−39	58	−11	39	206	1		
		6383	−30	67	+23	41	218	21		
		6382	−17	80	−9	18	24	2		
		6380	−17	80	−11	18	24	7		
		6377	+45	142	−9	45	461	40		
		6373	+80	177	+15	82	145	2		
				(97)	(−6)		1,574	79		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1939	h m		°	°	°	°				
Apr. 10	11 3	6386	−69	15	+10	71	218	2	G	U. S. Naval.
		6387	−67	17	−7	66	12	3		
		6385	−51	33	+21	58	109	2		
		6384	−43	41	−17	44	194	2		
		6381	−25	59	−11	26	194	2		
		6383	−17	67	+23	34	206	24		
		6382	−1	83	−8	3	36	4		
		6380	+3	87	−10	5	24	1		
		6388	+34	118	+12	37	24	1		
		6377	+59	143	−9	58	291	13		
				(84)	(−6)		1,308	54		
Apr. 11	11 25	6386	−54	17	+10	57	145	4	G	Do.
		6387	−53	18	−7	53	24	4		
		6385	−39	32	+21	47	97	3		
		6384	−30	41	−17	32	145	3		
		6381	−11	60	−11	12	145	4		
		6383	−4	67	+23	29	242	37		
		6380	+11	82	−11	12	24	4		
		6382	+15	86	−8	16	24	3		
		6391	+21	92	+10	26	6	2		
		6390	+43	114	+15	48	48	7		
		6389	+67	138	+13	69	24	3		
		6377	+70	141	−7	70	97	4		
		6377	+80	151	−9	80	145	5		
				(71)	(−6)		1,166	83		
Apr. 12	12 3	6396	−77	340	+2	78	48	4	VG	Do.
		6386	−40	17	+10	43	194	3		
		6387	−38	19	−7	38	24	2		
		6385	−25	32	+22	37	121	2		
		6384	−17	40	−17	20	145	3		
		6381	+2	59	−11	6	194	1		
		6383	+10	67	+22	29	218	38		
		6394	+11	68	+3	14	12	3		
		6393	+21	78	+8	25	36	11		
		6392	+23	80	+11	29	12	5		
		6391	+35	92	+9	39	24	4		
		6390	+56	113	+15	60	145	10		
		6377	+81	138	−8	81	12	3		
		6389	+81	138	+13	83	12	4		
				(57)	(−6)		1,197	93		
Apr. 13	11 15	6396	−62	342	+1	62	85	1	F	Do.
		6395	−33	11	+12	38	291	15		
		6386	−27	17	+10	31	121	4		
		6387	−25	19	−6	25	24	1		
		6385	−13	31	+21	30	73	1		
		6384	−4	40	−17	12	97	2		
		6381	+15	59	−11	16	145	2		
		6383	+27	71	+22	38	73	6		
		(*)	+28	72	−7	28	24	2		
		6393	+33	77	+7	36	48	4		
		6382	+39	83	−10	39	145	8		
		6390	+69	113	+15	71	48	6		
				(44)	(−6)		1,174	52		
Apr. 14	11 24	6398	−60	331	+18	65	24	1	F	Do.
		6396	−48	343	+1	49	61	1		
		6395	−19	12	+12	26	970	25		
		6386	−14	17	+10	21	145	1		
		6387	−14	17	−6	14	61	3		
		6385	−2	29	+21	27	73	1		
		6384	+9	40	−17	15	121	2		
		6381	+29	60	−11	30	121	1		
		6383	+39	70	+22	47	48	3		
		6393	+47	78	+7	49	36	3		
		6382	+53	84	−9	53	291	20		
				(31)	(−6)		1,951	61		
Apr. 15	10 42	6398	−48	330	+19	55	97	8	VG	Mount Wilson.
		6396	−35	343	+1	36	97	7		
		6397	−26	352	+12	31	18	4		
		6395	−5	13	+13	19	970	45		
		6387	−2	16	−7	3	24	1		
		6386	+1	19	+9	15	145	12		
		6385	+12	30	+21	29	73	2		
		6400	+12	30	−21	19	36	3		
		6399	+21	39	+16	30	24	3		
		6384	+21	39	−19	25	97	6		
		6381	+42	60	−11	42	145	1		
		6383	+52	70	+22	59	18	5		
		6393	+61	79	+7	62	6	1		
		6382	+68	86	−10	67	485	9		
				(18)	(−6)		2,235	107		
Apr. 16	9 1	6402	−80	286	+9	80	145	3	VG	Do.
		6401	−66	300	+17	69	24	3		
		6398	−35	331	+19	42	194	15		
		6396	−20	346	+1	21	36	5		
		6397	−15	351	+13	23	18	1		
		6395	+8	14	+13	19	1,067	50		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1939	h m		°	°	°	°				
Apr. 16	9 1	6387	+10	16	−7	10	24	3		Mount Wilson.
		6386	+12	18	+9	18	97	10		
		6385	+22	28	+21	33	61	1		
		6384	+33	39	−17	35	109	4		
		6381	+53	59	−11	54	109	2		
		6382	+81	87	−10	81	485	8		
				(6)	(−6)		2,369	105		
Apr. 17	11 44	6402	−63	288	+10	65	109	5	VG	Do
		6401	−52	299	+18	56	97	7		
		6398	−20	331	+19	31	242	35		
		6397	0	351	+13	18	12	8		
		6396	+5	356	+2	7	48	6		
		6395	+23	14	+13	29	970	56		
		6387	+25	16	−7	25	24	1		
		6386	+27	18	+9	30	73	6		
		6385	+40	31	+20	46	36	1		
		6384	+48	39	−18	50	145	5		
		6381	+69	60	−12	69	109	3		
				(351)	(−5)		1,865	133		
Apr. 18	15 6	6402	−49	287	+10	51	206	4	G	U. S. Naval.
		6401	−38	298	+18	44	48	5		
		6398	−6	330	+20	26	218	16		
		6395	+39	15	+13	43	727	30		
		6386	+41	17	+9	44	97	1		
		6385	+54	30	+21	59	24	1		
		6384	+62	38	−17	63	97	1		
		6381	+82	58	−11	82	48	2		
				(336)	(−5)		1,465	60		
Apr. 19	9 0	6406	−88	238	−15	88	48	1	G	Mount Wilson.
		6405	−75	251	+24	76	242	7		
		6402	−38	288	+11	41	170	7		
		6401	−21	305	+17	30	73	12		
		6398	+7	333	+20	26	218	15		
		6395	+51	17	+13	54	485	25		
		6386	+53	19	+10	56	97	5		
		6385	+66	32	+21	69	48	2		
		6384	+70	36	−16	70	97	1		
				(326)	(−5)		1,478	75		
Apr. 20	12 2	6406	−78	233	−16	78	1,212	20	F	U. S. Naval.
		6408	−77	234	+5	77	145	3		
		6407	−72	239	+31	76	630	12		
		6405	−62	249	+24	66	388	6		
		6402	−25	286	+10	29	242	9		
		6401	−7	304	+17	22	48	4		
		6404	−1	310	−17	13	121	10		
		6398	+20	331	+19	31	145	8		
		6403	+27	338	−3	27	24	4		
		6395	+64	15	+15	67	279	8		
		6386	+67	18	+10	68	61	1		
				(311)	(−5)		3,295	85		
Apr. 21	10 52	6406	−65	234	−16	66	1,357	60	VG	Do.
		6408	−63	236	+4	64	170	1		
		6407	−60	239	+30	66	679	12		
		6405	−48	251	+24	55	436	3		
		6402	−11	288	+10	18	242	7		
		6411	+5	304	+17	22	36	7		
		6404	+13	312	−17	18	339	30		
		6398	+35	334	+18	41	121	1		
		6395	+78	17	+15	79	279	2		
		6386	+80	19	+10	80	63	1		
				(299)	(−5)		3,722	124		
Apr. 22	11 27	6406	−51	234	−17	52	1,454	35	P	Do.
		6408	−49	236	+3	50	145	1		
		6407	−48	237	+28	51	824	12		
		6405	−36	249	+23	45	436	7		
		6409	−14	271	−15	17	12	2		
		6402	+2	287	+10	15	145	4		
		6404	+27	312	−17	29	388	12		
		6398	+48	333	+20	53	97	1		
				(285)	(−5)		3,501	74		
Apr. 23	11 34	6410	−72	200	−11	72	291	2	F	Do.
		6406	−38	234	−16	39	1,648	30		
		6408	−34	238	+4	35	121	1		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
Apr. 23	h m 11 34	6407	° −33	° 239	° +29	° 46	727	12		U. S. Naval.
		6405	−22	250	+25	36	533	15		
		6409	−1	271	−14	10	291	15		
		6402	+15	287	+10	21	194	7		
		6404	+40	312	−18	41	339	9		
		6398	+61	333	+18	65	145	2		
				(272)	(−5)		4,289	93		
Apr. 24	11 1	6411	−61	198	+25	67	24	2	F	Do.
		6410	−60	199	−11	60	291	1		
		6406	−25	234	−16	28	1,406	23		
		6407	−21	238	+30	40	727	12		
		6408	−21	238	+4	23	121	1		
		6405	−10	249	+24	30	533	13		
		6409	+12	271	−13	15	291	18		
		6402	+30	289	+9	33	121	2		
		6404	+52	311	−18	54	388	11		
		6398	+74	333	+18	76	145	1		
				(259)	(−5)		4,047	84		
Apr. 25	11 30	6410	−58	188	−15	59	18	3	G	Do.
		6411	−48	198	+23	55	18	1		
		6410	−47	199	−11	48	242	2		
		6412	−22	224	−11	43	97	7		
		6416	−11	235	−17	16	1,164	40		
		6407	−10	236	+30	36	582	4		
		6408	−8	238	+4	11	97	1		
		6405	+3	249	+25	30	533	23		
		6409	+27	273	−13	28	388	28		
		6402	+35	281	+9	38	24	1		
		6402	+42	288	+9	45	97	1		
		6404	+60	306	−18	61	145	11		
		6404	+69	315	−15	69	145	1		
				(246)	(−5)		3,550	123		
Apr. 26	11 18	6414	−80	152	−21	80	145	2	VG	Do.
		6413	−80	152	+21	80	194	3		
		(*)	−71	161	+12	72	36	3		
		6413	−70	162	+20	73	388	4		
		6410	−45	187	−15	46	24	1		
		6410	−32	200	−11	33	291	13		
		6412	−9	223	−10	10	170	1		
		6406	+2	234	−17	12	1,115	50		
		6407	+2	234	+30	35	630	12		
		6407	+3	235	+25	30	12	1		
		6408	+7	239	+4	10	97	2		
		6405	+15	247	+25	32	388	22		
		6409	+40	272	−13	41	364	22		
		6402	+56	288	+9	58	145	3		
		6404	+72	304	−17	72	61	3		
		6404	+85	317	−15	85	194	1		
				(232)	(−5)		4,254	143		
Apr. 27	15 26	6414	−75	142	−20	74	48	4	VG	Do.
		6414	−65	152	−20	65	121	5		
		6413	−63	154	+22	66	97	15		
		6415	−58	159	+12	59	12	2		
		6413	−56	161	+21	60	291	13		
		6410	−19	198	−12	20	242	18		
		6412	+3	220	−11	8	36	5		
		6412	+9	226	−11	11	24	3		
		6406	+16	233	−17	21	824	57		
		6407	+18	235	+30	38	751	2		
		6408	+22	239	+4	23	97	11		
		6405	+32	249	+24	40	436	22		
		6409	+57	274	−13	57	315	12		
		6402	+70	287	+8	70	97	2		
				(217)	(−5)		3,391	171		
Apr. 28	9 4	6414	−58	140	−20	59	97	8	G	Mount Wilson.
		6413	−50	157	+21	55	267	18		
		6415	−46	161	+12	48	48	10		
		6416	−21	186	+30	39	12	3		
		6410	−7	200	−11	10	291	25		
		6412	+13	220	−11	15	12	3		
		6406	+27	234	−17	30	873	35		
		6407	+28	235	+30	42	727	20		
		6408	+33	240	+5	35	121	1		
		6405	+43	250	+24	50	242	15		
		6409	+69	276	−13	68	242	9		
		6402	+82	289	+8	83	48	1		
				(207)	(−4)		2,980	148		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1939	h m		°	°	°	°				
Apr. 29	10 41	6418	−76	117	+11	77	388	7	VG	Mount Wilson.
		6417	−42	151	−11	42	97	12		
		6414	−39	154	−20	41	48	9		
		6413	−34	159	+21	41	194	25		
		6415	−31	162	+12	35	24	3		
		6416	−7	186	+31	35	24	6		
		6410	+8	201	−11	11	242	30		
		6412	+31	224	−11	32	48	15		
		6406	+41	234	−15	42	776	30		
		6407	+42	235	+30	53	630	20		
		6408	+47	240	+5	48	97	1		
		6405	+55	248	+23	60	145	3		
		6409	+85	278	−13	84	242	7		
				(193)	(−4)		2,955	170		
Apr. 30	9 0	6418	−63	118	+12	64	776	15	VG	Do.
		6419	−43	138	−15	44	48	9		
		6414	−38	143	−21	40	97	10		
		6417	−29	152	−11	30	121	15		
		6414	−28	153	−21	33	61	15		
		6413	−21	160	+20	31	170	30		
		6415	−19	162	+11	24	48	5		
		6410	+19	200	−11	21	145	12		
		6412	+44	225	−11	44	48	4		
		6407	+54	235	+30	61	630	16		
		6406	+54	235	−15	54	485	21		
		6408	+60	241	+44	61	97	1		
		6405	+68	249	+22	70	73	4		
				(181)	(−4)		2,799	157		

Mean daily area for 30 days=2,133.
*Not numbered.
Plate quality=F=fair; G=good; VG=very good; P=poor.

PROVISIONAL SUNSPOT RELATIVE NUMBERS FOR APRIL 1939

[Dependent alone on observations at Zurich]

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

April 1939	Relative numbers	April 1939	Relative numbers	April 1939	Relative numbers
1	*Ec* 34	11	*a* 103	21	125
2	*Mc* 85	12	*a* 100	22	*a* 115
3	83	13	*EWcc* 112	23	*Macd* 152
4	*a* 82	14	*Eaac* 126	24	151
5	74	15	*b* 121	25	*a* 134
6	*ad* 70	16	*d* 141	26	*abd* 134
7	*Ecd* 63	17	109	27	----------
8	----------	18	102	28	*ad* --
9	*dd* 89	19	*ad* 94	29	----------
10	*Wc* 98	20	*Macdd* 125	30	140

Mean, 26 days=106.2

Middle, large bright chromospheric eruption observed—

	U. T.			
	h	m	h	m
April 16	8	33 to	9	45 M.
April 16	8	35	9	50 W.
April 21	9	00	9	20 E.
April 22	8	25	8	45 M.
April 24	11	15	11	30 W.

a=Passage of an average-sized group through the central meridian.
b=Passage of a large group through the central meridian.
c=New formation of a group developing into a middle-sized or large center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central-circle zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE in charge]

By B. FRANCIS DASHIELL

The 362 airplane and 233 radiosonde upper-air observations shown in tables 1 and 1a for the month of April also include the first of a series of radiosonde reports from Bermuda. Of all observations made exclusively within the United States, 96 percent and 85 percent reached 4 and 5 kilometers, respectively. Radiosonde observations showed some improvement, with 97, 92, 73, and 38 percent of all flights reaching 5, 10, 15, and 18 kilometers, respectively, while a few individual ascents rose to 23 kilometers. At Oakland, Calif., and Washington, D. C., 50 percent and 47 percent, respectively, of all flights launched at the surface attained 18 kilometers. The April wind resultants include those from 3 new pilot balloon stations operating at Des Moines, Iowa, Milwaukee, Wis., and Pueblo, Colo. A detailed explanation of tables 1, 1a, 2, 3, and 4, and charts VIII, IX, X, XI, and XII, will be found in the January 1939 issue of the MONTHLY WEATHER REVIEW.

The weather in April was in contrast with that which prevailed during March over the eastern half of the country. As shown on chart I, mean surface temperatures (° F.) were subnormal east of the Mississippi Valley with the coldest weather over the Great Lakes region, and abnormal temperatures occurred over Nevada and the interior of California. Above the surface, in the free air, the mean temperatures (° C.) for April were lowest over Sault Ste. Marie, Mich., and Fargo, N. Dak., at all levels up to 8 kilometers; over Fargo, N. Dak., from 9 to 12 kilometers; over Oklahoma City, Okla., from 13 to 18 kilometers; and over Oklahoma City, Okla., and Oakland, Calif., at 19 and 20 kilometers. However, the lowest mean temperatures for the current month were recorded over Bermuda, between 12 and 18 kilometers.

A minimum upper-air mean temperature of —69.5° C. was reported from Bermuda, while the lowest for the United States (—63.2° C.) was recorded at Oklahoma City, Okla.; both occurring at 17 kilometers. Highest mean temperatures for the month were recorded over Pensacola, Fla., at 0.5, 1, and 5 kilometers; over El Paso, Tex., at all levels from 1.5 to 4 kilometers; at Oakland, Calif., from 6 to 9 kilometers; over Nashville, Tenn., at 10 and 11 kilometers; and over Sault Ste. Marie, Mich., from 12 to 20 kilometers, inclusive.

The April mean free-air temperatures listed in tables 1 and 1a were seasonally higher at all levels up to 5 kilometers than during March. At the 5-kilometer level the current month was cooler than April 1938, except over stations in the far Northwest and in California. Above 5 kilometers at all stations April was warmer than the preceding month, but Oakland, Calif., became cooler in the levels higher than 10 kilometers.

A center of low mean pressure was indefinitely located north of the Great Lakes region and northeast toward Newfoundland, as shown on charts VIII, IX, X, and XI. At these same levels high pressure prevailed over Bermuda and extended westward in a belt to Pensacola, Fla., El Paso, Tex., and San Diego, Calif. Pressures during April were slightly higher in the North and lower in the South than in March. The pressure differences between the "high" and "low" areas, or gradient between Sault Ste. Marie, Mich., and Pensacola, Fla., at each level, increased with altitude up to 5 kilometers, but were found to be less than the differences noted in March.

Mean relative humidity, from the surface up to 8 kilometers, was highest over Sault Ste. Marie, Mich., and

comparatively high over Washington, D. C., at all levels above 4 kilometers. Bermuda reported high humidity at 0.5, 1, 1.5, and 2 kilometers, but at the higher levels the air was much drier. The driest air in the lower levels appeared over El Paso, Tex., and Norfolk, Va.; and over Oakland, Calif., Oklahoma City, Okla., and Bermuda, at all levels above 5 kilometers.

The April resultant winds, based on 5 a. m. and 5 p. m. observations, as shown on charts VIII, IX, X, and XI, showed northwesterly directions at 1.5 kilometers except for an area that extended from Texas to the Atlantic, and another in the far Northwest. At 3, 4, and 5 kilometers the directions were northwesterly except over the extreme southeastern portion of the United States, and Cuba and Mexico. At the four levels shown by the charts, winds from the northwest quadrant prevailed in 55, 79, 83, and 87 percent of all cases at 1.5, 3, 4, and 5 kilometers respectively. Even at the highest levels some southwesterly winds persisted. The April resultant wind directions were slightly north of those recorded in March, and this was particularly noticeable over the eastern half of the country at 3 kilometers.

Comparing the April 5 a. m. (E. S. T.) resultant wind directions at 1.5 and 3 kilometers (charts VIII and IX) with normal directions computed for the same levels at 24 well-distributed stations, it was found that most of the current winds departed from the normal directions by a clockwise rotation. However, outstanding exceptions occurred at Key West, Fla., and Atlanta, Ga., where the departures from normal were oriented by a counterclockwise rotation. Medford, Oreg., and Oakland, Calif., showed the largest degree of clockwise departures at 1.5 kilometers. Using these 5 a. m. normals in comparison with 5 p. m. observations at 4 and 5 kilometers (charts X and XI), it was found that large counterclockwise departures existed over Key West, Fla., and Medford, Oreg. Large clockwise departures were noted over Salt Lake City, Utah, at 3 and 4 kilometers. Resultant velocities for April were greater than normal at most of the stations for which normals have been computed, particularly over the Central States. The highest departure noted was +9.4 m. p. s. over Seattle, Wash., at 5 kilometers.

Table 2 shows 5 p. m. (E. S. T.) resultant wind directions and velocities at a number of selected stations at all levels. Comparing 20 of these stations with their 5 a. m. normals, it was found that clockwise departures occurred at all levels over Cheyenne, Wyo., and counterclockwise departures at Sault Ste. Marie, Mich., and Washington, D. C. The most outstanding departures were noted at Salt Lake City, Utah, Omaha, Nebr., Medford, Oreg., Seattle, Wash., and Fargo, N. Dak.; while the winds at Chicago, Ill., Oakland, Calif., and St. Louis, Mo., were about normal. Resultant velocities were higher than normal in most cases, except at Cheyenne, Wyo., and San Diego, and Oakland, Calif. There were excessive velocities at Omaha, Nebr., and Seattle, Wash., being as much as +8.4 m. p. s. over the latter station at 5 kilometers.

The resultant winds for April, as shown in table 2, when compared to the winds of the previous month, showed higher velocities during April at most stations with the exception of Winslow, Ariz., Las Vegas, Nev., Havre, Mont., Fargo, N. Dak., Billings, Mont., Abilene, Tex., Albuquerque, N. Mex., Oklahoma City, Okla., St. Louis, Mo., and Chicago, Ill. The April resultant velocities at Medford, Oreg., and Miami, Fla., were considerably higher at all levels (up to 12 kilometers at the former) than during March. At Chicago, Ill., Fargo, N. Dak., Oklahoma City, Okla., St. Louis, Mo., and Winslow, Ariz., the March directions generally were south of (counterclockwise rotation) the April directions, and the wind velocities were higher.

The resultant winds for April at 1.5 and 3 kilometers (table 2) based on 5 p. m. observations, when compared with the current winds (charts VIII and IX) based on 5 a. m. observations, showed that the morning directions were definitely more northerly than the 5 p. m. directions. The 5 a. m. velocities, too, were slightly higher in most cases. However, at Miami, Fla., the 5 a. m. resultant directions were more southerly than at 5 p. m. at both levels by an average of 28°, and the resultant velocities lower by an average of −1.8 m. p. s.

The maximum altitudes reached by pilot balloons were 17,757 meters at Denver, Colo., and 17,556 meters at Omaha, Nebr. Altitudes over 15 kilometers were reached at 13 stations; from 10 to 15 kilometers at 39 stations, from 5 to 10 kilometers by 31 stations; and only one station failed to reach 5 kilometers. Maximum altitudes during April were somewhat higher than those reached in March, being confined to the Great Lakes region, Ohio Valley, New England, Texas, the southern Rocky Mountain region and southern Pacific coast. Practically all maximum altitudes were reached during the closing days of April—on the 28th over the northern Rocky Mountains, on the 29th over the north-central States and Upper Mississippi Valley, and on the 30th over the lower Ohio and Mississippi Valleys.

Table 3 shows the maximum wind velocities that occurred over the United States during April. Some relatively high wind speeds were recorded between the surface and 2.5 kilometers, the greatest being 51.4 m. p. s. from the north on the 5th, over Sandberg, Calif. This station also reported a maximum wind between 2.5 and 5 kilometers (56.1 m. p. s.) on the 5th. Above 5 kilometers, a maximum velocity of 80 m. p. s. from the northwest (179 miles per hour) occurred over Redding, Calif., on the 4th, at 13,270 meters. These velocities appear to be the highest recorded in the upper air over California in the levels below 2.5 kilometers, and above 5 kilometers.

The mean insentropic chart [1] for April shows two moist tongues: One enters the country in Texas and curves anticyclonically to the northeast and east. This tongue was present on about one-third of the days, which is not characterized by winds blowing along its axis. The precipitation excess above normal in the Northeastern States seems to be associated with this moist tongue. Another moist tongue was off the Atlantic coast, also on about one-third of the days; its northern portion was located by means of 22 daily radiosondes released by the International Ice Patrol cutters S. S. *Champlain* and S. S. *Chelan* at about latitude 44.5° N., longitude 48.5° W. In the west, the effect of the plateau is seen in the northward bulge of the contour and moisture lines.

[1] This chart and the following discussion have been prepared by the Air Mass Section of the Meteorological Research Division.

TABLE 1.—*Mean free-air barometric pressures (P.) in mb., temperatures (T.) in °C., and relative humidities (R. H.) in percent obtained by airplanes during April 1939*

Stations and elevations in meters above sea level	Altitude (meters) m. s. l.																													
	Surface				500			1,000			1,500			2,000			2,500			3,000			4,000			5,000		
	Number of observations	P.	T.	R. H.	P.	T.	R. H.	P.	T.	R. H.	P.	T.	R. H.	P.	T.	R. H.	P.	T.	R. H.	P.	T.	R. H.	P.	T.	R. H.	P.	T.	R. H.
Billings, Mont. (1,090 m.)	30	892	5.6	61							849	6.7	53	798	3.8	53	750	0.2	56	705	−3.4	58	620	−9.9	59	544	−16.2	57
Cheyenne, Wyo. (1,873 m.)	29	810	2.4	72										797	4.5	62	750	2.9	56	705	−0.6	53	621	−7.9	55	545	−15.9	56
Chicago, Ill. (187 m.)	30	991	4.7	77	954	5.5	66	897	3.8	64	843	1.2	64	792	−1.2	60	744	−3.4	54	698	−6.0	50	614	−10.9	48	538	−17.1	49
Coco Solo, C. Z.[1] (15 m.)	29	1,012	26.0	86	958	22.5	94	905	19.6	91	854	17.2	82	805	15.1	70	759	13.2	54	715	10.6	49	634	5.4	39			
El Paso, Tex. (1,193 m.)	30	881	13.8	36							850	15.6	32	800	13.0	31	754	10.0	30	710	6.4	31	627	−1.1	33	552	−8.6	36
Lakehurst, N. J.[1] (39 m.)	23	1,011	5.0	74	955	5.8	67	898	2.9	67	844	0.6	69	793	−1.8	69	744	−3.8	69	699	−5.9	67	614	−11.1	62			
Norfolk, Va.[1] (10 m.)	18	1,017	10.8	76	959	11.4	47	903	8.5	46	849	5.1	50	799	2.8	46	751	0.7	40	705	−2.2	39	621	−6.8	29	546	−13.3	27
Pearl Harbor, T. H.[1] (6 m.)	30	1,016	20.5	80	960	19.1	76	906	15.9	78	853	13.4	76	804	11.2	67	756	8.9	61	712	6.9	54	630	2.1	41			
Pensacola, Fla.[1] (13 m.)	30	1,017	15.8	89	960	16.0	75	905	14.7	67	853	12.0	65	803	9.7	56	756	7.6	47	711	4.6	45	628	−1.4	35	554	−7.7	34
St. Thomas, V. I.[1 2] (8 m.)																												
Salt Lake City, Utah (1,288 m.)	30	871	7.1	63							850	10.1	52	800	7.6	51	752	4.2	52	707	0.6	55	623	−6.1	57	548	−12.4	56
San Diego, Calif.[1] (10 m.)	27	1,016	14.4	80	958	13.3	77	904	14.7	60	852	13.3	50	802	11.7	41	755	8.7	36	710	5.2	34	627	−1.3	31	552	−9.3	28
Seattle, Wash.[1] (10 m.)	26	1,019	10.7	67	961	8.1	66	904	5.5	65	851	3.2	61	800	0.7	55	751	−1.2	49	706	−3.7	47	620	−9.2	40			
Spokane, Wash. (597 m.)	30	947	6.3	69				902	9.4	52	849	6.6	50	799	2.8	52	751	−0.7	54	705	−4.0	52	621	−9.7	53	544	−15.5	55

[1] Navy.
[2] Flights discontinued temporarily.

Observations taken about 4 a. m. 75th meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.
NOTE.—None of the means included in this table are based on less than 15 surface or 5 standard-level observations.

TABLE 1a.—*Mean free-air barometric pressures (P) in mb., temperatures (T) in °C., and relative humidities (R H) in percent obtained by radiosonde during April 1939*

Altitude (meters) m. s. l.	Stations and elevations in meters above sea level																													
	Bermuda[2] (50 m.)				Fargo, N. Dak. (274 m.)				Nashville, Tenn. (180 m.)				Oakland, Calif. (2 m.)				Oklahoma City, Okla. (391 m.)				Omaha, Nebr. (300 m.)				Sault Ste. Marie, Mich. (221 m.)				Washington, D. C.[1] (13 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	24	1,016	17.9	87	30	981	1.0	80	30	994	10.1	78	30	1,018	10.4	89	29	969	11.3	65	30	979	7.4	69	30	986	−1.6	85	30	1,015	9.2	73
500	24	964	16.0	86	30	954	2.7	76	30	957	10.4	70	30	959	10.4	78	29	956	12.1	62	30	955	7.7	65	30	952	−1.2	83	30	956	7.4	65
1,000	24	909	12.4	85	30	897	1.1	71	30	901	8.3	69	30	903	11.9	56	29	901	11.8	55	30	899	6.0	63	30	894	−2.1	78	30	899	5.0	68
1,500	24	856	9.5	75	30	842	−1.2	68	30	847	5.7	65	30	851	10.4	45	29	848	9.3	53	30	845	4.1	62	30	839	−4.3	77	30	845	2.5	70
2,000	24	805	7.0	69	30	791	−3.2	66	30	797	3.8	63	30	800	7.7	40	29	798	6.8	50	30	795	1.6	59	30	787	−6.6	76	30	794	0.6	67
2,500	24	758	5.3	58	30	743	−5.2	63	30	749	1.7	61	30	753	4.8	39	29	751	4.8	48	30	746	−1.2	58	30	738	−8.9	72	30	746	−1.6	66
3,000	24	712	2.6	52	30	696	−7.9	62	28	704	−1.3	63	30	708	2.2	38	29	706	1.8	46	30	701	−4.1	57	30	692	−11.4	69	30	700	−4.2	65
4,000	24	629	−2.9	43	30	612	−13.8	61	27	620	−5.8	59	30	625	−3.6	35	28	623	−4.2	40	30	617	−9.2	53	30	606	−16.7	65	30	616	−9.4	64
5,000	24	554	−9.1	40	30	535	−20.0	57	27	545	−11.8	56	30	550	−9.9	33	28	548	−11.2	39	29	541	−15.5	50	29	530	−23.2	63	30	541	−14.9	59
6,000	24	486	−15.6	39	30	467	−26.8	55	26	478	−18.2	55	30	482	−17.1	31	28	480	−18.1	40	29	473	−22.5	47	29	462	−29.7	60	30	473	−21.2	58
7,000	24	425	−22.8	38	30	406	−34.0	54	25	417	−25.2	54	30	421	−24.3	31	27	419	−25.8	40	26	412	−30.0	46	28	400	−36.3	59	30	412	−27.4	57
8,000	24	370	−30.5	37	30	351	−41.6	54	25	362	−32.1	52	30	366	−31.7	31	26	365	−33.1	39	26	357	−37.6	45	28	346	−42.6	60	30	358	−34.3	57
9,000	24	320	−38.4	36	30	302	−48.3	----	25	314	−39.4	52	30	317	−39.3	30	25	315	−40.4	37	26	308	−45.1	----	28	298	−48.1	----	30	310	−41.1	56
10,000	24	276	−46.3	----	29	259	−54.3	----	25	270	−46.2	----	30	274	−46.5	----	25	272	−47.7	----	25	265	−50.7	----	28	255	−52.0	----	30	267	−47.2	----
11,000	24	237	−54.1	----	28	221	−58.1	----	25	232	−51.9	----	30	235	−53.2	----	25	233	−54.1	----	25	227	−55.1	----	28	219	−54.3	----	30	229	−52.3	----
12,000	24	202	−60.2	----	27	188	−59.3	----	24	199	−55.6	----	30	201	−58.1	----	25	199	−59.0	----	25	194	−58.1	----	27	187	−54.7	----	27	196	−56.0	----
13,000	24	172	−63.8	----	25	160	−59.3	----	23	170	−57.8	----	28	171	−60.4	----	24	169	−61.9	----	25	165	−59.2	----	26	160	−54.8	----	26	167	−57.7	----
14,000	24	146	−64.5	----	24	136	−58.5	----	23	144	−57.7	----	28	146	−60.4	----	23	144	−61.3	----	25	140	−58.6	----	25	137	−54.8	----	24	143	−58.1	----
15,000	21	124	−66.4	----	20	116	−59.0	----	20	123	−58.6	----	28	124	−59.9	----	17	123	−61.3	----	20	120	−59.3	----	24	117	−55.6	----	23	122	−58.5	----
16,000	18	105	−69.2	----	16	98	−59.2	----	18	105	−59.4	----	27	106	−60.6	----	13	104	−63.0	----	16	102	−60.0	----	22	100	−56.6	----	21	103	−59.0	----
17,000	13	88	−69.5	----	13	83	−58.5	----	16	89	−60.2	----	21	90	−60.7	----	11	89	−63.2	----	11	86	−60.5	----	14	85	−57.1	----	18	88	−59.4	----
18,000	8	75	−66.6	----	7	70	−58.4	----	10	75	−60.6	----	15	76	−61.3	----	9	75	−63.1	----	6	73	−60.5	----	11	72	−57.3	----	14	74	−59.3	----
19,000	6	63	−61.7	----					6	64	−59.4	----	8	65	−61.9	----	7	64	−62.8	----					9	62	−57.8	----	9	63	−59.1	----
20,000													5	55	−61.9	----	5	54	−62.3	----					5	52	−57.5	----				

[1] Navy.
[2] Operated by Massachusetts Institute of Technology.

Observations taken about 4 a. m. 75th meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—None of the means included in this table are based on less than 15 surface or 5 standard-level observations.
Number of observations refers to pressure only as temperature and humidity data are missing for some observations at certain levels, also, the humidity data are not used in daily observations when the temperature is below −40° C.

TABLE 2.—*Free-air resultant winds based on pilot-balloon observations made near 5 p. m. (E. S. T.) during April 1939*

[Directions given in degrees from North (N=360°, E=90°, S=180°, W=270°)—Velocities in meters per second (superior figures indicate number of observations)]

Altitude (meters) m. s. l.	Abilene, Tex. (537 m.)		Albuquerque, N. Mex. (1,554 m.)		Atlanta, Ga. (302 m.)		Billings, Mont. (1,095 m.)		Boise, Idaho (850 m.)		Brooklyn, N. Y. (15 m.)		Brownsville, Tex. (7 m.)		Buffalo, N. Y. (220 m.)		Burlington, Vt. (132 m.)		Charleston, S. C. (18 m.)		Cheyenne, Wyo. (1,873 m.)		Chicago, Ill. (192 m.)		Cincinnati, Ohio (157 m.)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	307	0.4^{30}	240	1.5^{30}	260	3.0^{30}	314	2.2^{30}	299	2.1^{30}	256	4.0^{27}	128	5.0^{29}	251	4.5^{28}	299	1.5^{24}	214	3.0^{30}	292	4.0^{27}	262	2.4^{27}	261	3.0^{29}
500					258	4.3^{30}					260	6.3^{27}	135	4.9^{29}	264	6.9^{28}	276	2.6^{23}	214	5.2^{29}			258	3.6^{27}	253	5.7^{29}
1,000	287	0.5^{30}			258	5.2^{29}			306	3.1^{30}	264	8.0^{26}	169	2.9^{23}	258	7.7^{28}	273	3.9^{23}	235	6.8^{23}			268	4.6^{23}	252	7.0^{29}
1,500	213	1.4^{25}			252	5.8^{29}	307	2.6^{29}	297	3.2^{30}	274	10.2^{25}	193	1.6^{23}	258	8.6^{27}	263	4.6^{21}	246	8.0^{23}			271	7.0^{29}	254	7.7^{28}
2,000	241	2.7^{27}	230	2.7^{30}	260	7.0^{27}	311	4.2^{29}	300	3.6^{30}	280	12.7^{23}	275	2.2^{29}	268	8.7^{18}	274	5.4^{16}	258	10.4^{26}	293	4.4^{27}	283	9.3^{12}	269	7.8^{18}
2,500	268	4.6^{24}	248	3.3^{30}	277	9.3^{24}	297	5.4^{27}	307	4.1^{30}	287	15.1^{19}	268	3.7^{19}	269	9.9^{12}	285	7.3^{15}	262	12.2^{24}	299	6.4^{27}	290	10.3^{13}	295	10.1^{21}
3,000	277	6.9^{23}	256	4.2^{30}	270	11.5^{22}	285	7.0^{23}	299	5.2^{29}			289	6.6^{18}			293	9.0^{12}	263	13.0^{21}	293	7.8^{16}	306	11.0^{11}		
4,000	278	9.7^{22}	279	7.8^{26}	281	13.5^{19}	281	7.5^{19}	286	7.3^{22}			276	10.9^{13}					266	16.2^{14}	291	9.0^{22}				
5,000	284	12.9^{20}	287	12.3^{24}	289	12.4^{11}	295	9.9^{14}	293	7.4^{16}			282	13.0^{10}					268	15.2^{11}	306	9.2^{13}				
6,000	291	14.3^{17}	292	16.0^{22}			293	8.7^{13}																		
8,000	291	16.8^{13}	295	20.5^{13}																						
10,000	293	16.3^{10}	303	22.8^{13}																						

Altitude (meters) m. s. l.	El Paso, Tex. (1,196 m.)		Fargo, N. Dak. (283 m.)		Greensboro, N. C. (271 m.)		Havre, Mont. (766 m.)		Houston, Tex. (21 m.)		Huron, S. Dak. (393 m.)		Las Vegas, Nev. (570 m.)		Little Rock, Ark. (82 m.)		Medford, Oreg. (410 m.)		Miami, Fla. (10 m.)		Minneapolis, Minn. (261 m.)		Nashville, Tenn. (194 m.)		New Orleans, La. (19 m.)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	245	2.3^{30}	346	1.4^{29}	242	2.9^{29}	288	2.2^{28}	142	1.7^{29}	337	3.5^{30}	96	1.0^{29}	160	1.0^{29}	318	2.3^{30}	130	3.2^{30}	304	2.5^{31}	250	2.4^{26}	262	0.1^{30}
500			354	4.2^{29}	251	4.2^{29}			164	2.5^{29}	341	4.0^{30}			201	2.3^{29}	315	2.6^{28}	143	3.3^{30}	312	2.9^{29}	229	3.3^{30}	189	2.4^{29}
1,000			347	3.6^{27}	250	5.8^{29}	271	3.8^{28}	234	1.4^{28}	334	3.9^{29}	107	0.8^{29}	240	3.4^{29}	298	2.2^{26}	198	2.4^{27}	282	3.2^{26}	237	4.5^{30}	216	2.8^{28}
1,500	254	3.1^{30}	331	4.3^{26}	254	7.2^{29}	267	3.8^{28}	289	2.9^{24}	313	4.9^{27}	184	0.4^{30}	260	5.7^{29}	266	1.5^{30}	230	2.9^{24}	271	5.3^{26}	250	6.1^{26}	247	3.3^{28}
2,000	265	3.0^{30}	325	5.3^{21}	267	9.7^{29}	275	4.5^{24}	285	6.1^{21}	304	5.9^{28}	245	2.2^{30}	273	6.9^{28}	238	2.2^{30}	255	4.0^{30}	278	6.4^{23}	256	7.3^{27}	262	5.3^{23}
2,500	268	2.9^{30}	324	6.0^{19}	275	13.4^{24}	277	6.1^{19}	280	7.1^{30}	312	8.5^{24}	257	3.1^{30}	284	7.4^{23}	237	3.4^{29}	264	5.3^{19}	296	6.3^{14}	263	8.3^{23}	278	6.5^{23}
3,000	267	4.3^{29}	323	6.1^{18}	274	15.9^{30}	288	7.1^{16}	277	9.2^{18}	313	10.9^{23}	292	2.3^{29}	286	9.0^{26}	244	4.7^{29}	265	7.2^{16}	319	9.7^{19}	275	10.4^{21}	282	7.1^{23}
4,000	266	6.9^{25}	320	9.0^{12}	268	18.6^{18}	290	9.6^{11}	293	8.6^{16}	321	11.3^{17}	289	3.7^{29}	284	12.8^{18}	251	7.1^{27}	251	6.5^{12}			272	13.2^{18}	290	9.0^{16}
5,000	264	8.9^{24}			292	18.1^{10}	282	9.2^{10}	295	10.7^{12}	324	13.8^{16}	288	4.8^{27}	296	14.3^{12}	258	8.7^{26}							304	12.2^{10}
6,000	276	11.4^{20}							297	12.1^{12}	316	14.2^{12}	316	8.4^{23}			260	10.5^{24}								
8,000	294	13.7^{10}									306	15.9^{10}	314	10.5^{20}			272	11.2^{27}								
10,000													322	14.7^{17}			255	10.4^{13}								
12,000													310	14.4^{14}			240	12.5^{10}								

Altitude (meters) m. s. l.	Oakland, Calif. (8 m.)		Oklahoma City, Okla. (402 m.)		Omaha, Nebr. (306 m.)		Reno, Nev. (1,346 m.)		St. Louis, Mo. (170 m.)		Salt Lake City, Utah (1,294 m.)		San Diego, Calif. (15 m.)		San Juan, P. R. (16 m.)		Sault Ste. Marie, Mich. (198 m.)		Seattle, Wash. (14 m.)		Spokane, Wash., (603 m.)		Washington, D. C. (10 m.)		Winslow, Ariz. (1,488 m.)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	260	5.5^{27}	246	0.9^{29}	315	3.6^{28}	249	1.8^{30}	233	1.5^{29}	308	3.0^{30}	279	4.0^{29}	84	6.7^{30}	301	3.4^{26}	251	2.4^{29}	239	3.0^{30}	271	1.6^{29}	263	3.3^{29}
500	290	3.7^{28}	242	1.1^{29}	310	3.9^{28}			260	2.7^{29}			293	2.4^{29}	97	9.5^{30}	315	4.6^{26}	236	2.3^{30}			246	4.6^{29}		
1,000	301	2.6^{28}	244	2.2^{29}	312	5.2^{28}			252	4.5^{26}			316	2.3^{23}	109	7.7^{30}	313	3.4^{23}	212	3.2^{27}	234	3.0^{30}	247	7.3^{26}		
1,500	304	2.6^{28}	258	3.2^{29}	293	6.0^{23}	248	1.7^{30}	259	5.7^{24}	308	3.2^{30}	339	1.1^{23}	112	6.0^{29}	299	3.4^{22}	185	4.0^{23}	236	3.6^{29}	254	9.5^{26}		
2,000	291	2.4^{28}	275	4.9^{27}	289	7.8^{24}	235	1.6^{30}	275	7.8^{20}	289	2.5^{30}	16	1.1^{21}	118	4.7^{19}	288	5.0^{20}	207	4.5^{21}	238	5.4^{28}	263	10.7^{23}	248	3.0^{30}
2,500	267	1.8^{28}	270	6.4^{24}	289	10.1^{24}	249	2.1^{30}	288	8.9^{17}	256	3.3^{29}	349	1.6^{20}	128	3.6^{14}	297	3.5^{19}	225	5.5^{19}	253	5.7^{23}	268	13.3^{22}	253	3.4^{30}
3,000	280	2.1^{28}	277	8.0^{26}	289	10.2^{21}	260	3.3^{29}	292	10.2^{16}	250	3.8^{28}	347	2.0^{17}	157	2.9^{10}	299	9.3^{17}	239	5.8^{17}	263	5.5^{19}	273	16.3^{16}	253	3.7^{30}
4,000	285	4.6^{26}	277	10.6^{26}	299	12.5^{16}	289	4.9^{23}	291	15.0^{12}	294	3.8^{21}	321	3.9^{16}			302	12.8^{11}	284	10.2^{13}	278	6.7^{17}			280	4.9^{23}
5,000	285	7.0^{25}	282	14.0^{26}	297	15.6^{16}	287	5.8^{26}			307	4.1^{13}	294	6.0^{13}					285	12.9^{10}	287	10.2^{14}			294	6.6^{23}
6,000	281	9.0^{23}	289	14.8^{16}	305	17.9^{13}	292	8.6^{23}					291	9.3^{11}											312	8.5^{23}
8,000	264	12.8^{14}	308	18.5^{10}			301	9.9^{17}																	308	14.4^{19}
10,000							312	8.8^{13}																	290	20.3^{18}

TABLE 3.—*Maximum free-air wind velocities, (M. P. S.), for different sections of the United States based on pilot balloon observations during April 1939*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station
Northeast [1]	42.0	WNW	1,690	3	Kylertown, Pa.	45.6	SW	3,590	10	Columbus, Ohio	57.0	NW	6,720	3	Cleveland, Ohio.
East-Central [2]	39.1	SSW	1,720	10	Nashville, Tenn.	48.4	WNW	4,530	12	Knoxville, Tenn.	49.6	NNW	7,020	4	Greensboro, N. C.
Southeast [3]	36.8	SW	2,500	19	Charleston, S. C.	40.5	SW	3,710	19	Charleston, S. C.	43.0	WSW	12,170	23	Charleston, S. C.
North-Central [4]	43.6	W	1,970	25	Minneapolis, Minn.	40.6	NNW	4,670	12	Minneapolis, Minn.	46.1	NNW	11,550	21	Huron, S. Dak.
Central [5]	41.9	SW	2,500	9	Evansville, Ind.	52.0	SW	2,930	9	Evansville, Ind.	52.8	W	11,240	9	Wichita, Kans.
South-Central [6]	40.0	NW	1,840	16	Del Rio, Tex.	35.0	NW	4,310	1	Memphis, Tenn.	41.4	W	5,210	7	Little Rock, Ark.
Northwest [7]	30.1	NW	2,500	5	Boise, Idaho	39.0	NW	4,830	15	Spokane, Wash.	45.2	W	17,380	28	Billings, Mont.
West-Central [8]	38.6	SSW	2,470	13	Modena, Utah	48.0	NW	5,000	7	Rock Springs, Wyo.	80.0	NW	13,270	4	Redding, Calif.
Southwest [9]	51.4	N	2,500	5	Sandberg, Calif.	56.1	N	2,550	5	Sandberg, Calif.	55.2	NW	5,920	10	Albuquerque, Mex.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during April 1939, classified according to the potential temperatures (10-degree intervals between 290° and 399° A.) with which they are identified. (Based on radiosonde observations.)*

Potential temperatures	Fargo, N. Dak.			Nashville, Tenn.			Oakland, Calif.			Oklahoma City, Okla.			Omaha, Nebr.			Sault Ste. Marie, Mich.			Washington, D. C.		
	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.
290–299	5	7.9	−55.6													4	6.8	−46.2			
300–309	5	8.0	−48.8							1	7.7	−46.0	3	7.8	−46.0	9	8.0	−50.7	1	9.1	−56.0
310–319	15	9.6	−57.0	4	8.5	−41.8	2	8.1	−40.0	6	9.1	−48.3	7	8.9	−49.1	14	9.2	−52.6	3	8.5	−45.0
320–329	14	10.9	−61.9	12	9.6	−47.0	10	10.5	−52.5	10	9.5	−46.8	17	10.1	−53.1	13	10.2	−55.3	8	9.8	−49.5
330–339	6	11.7	−62.3	19	11.0	−54.5	22	11.4	−58.0	17	11.5	−58.6	17	11.5	−58.6	12	11.2	−57.8	15	11.3	−56.3
340–349	5	12.5	−62.4	14	12.5	−60.6	13	13.0	−65.7	10	12.6	−62.7	10	12.4	−61.1	9	11.4	−56.3	6	12.4	−61.3
350–359	1	13.6	−67.0	8	12.8	−58.9	5	13.1	−61.4	6	13.6	−65.2	7	12.6	−58.1	2	12.8	−60.5	7	13.6	−63.6
360–369	1	12.2	−54.0	1	13.1	−56.0	3	13.3	−57.0	3	13.5	−60.7	3	12.8	−55.7	4	12.5	−56.0	1	13.8	−69.0
370–379				5	14.2	−60.2	1	14.4	−61.0				3	13.8	−58.3	3	13.1	−53.7	1	14.2	−58.0
380–389	1	15.0	−64.0	2	14.8	−59.5	1	14.2	−52.0	1	14.8	−58.0	4	14.3	−57.8						
390–399				1	15.4	−60.0				1	16.4	−70.0	1	15.2	−58.0	1	13.5	−48.0			
All (weighted means)		10.4	−58.8		11.6	−54.9		11.8	−58.0		11.5	−56.9		11.4	−56.0		10.2	−54.2		11.4	−56.5
Mean potential temperature	322.3			341.8			339.2			337.6			338.5			328.6			337.2		

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD in Charge]

The report for April 1939 will be included in the May issue of the REVIEW.—*Editor.*

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. E. HURD, acting in charge]

NORTH ATLANTIC OCEAN, APRIL 1939

By H. C. HUNTER

Atmospheric pressure.—The monthly means of pressure nowhere showed any extraordinary departure from normal. The eastern and southwestern regions had somewhat higher values than normal, but the central and northwestern had lower than normal. The greatest departure was to be found near Newfoundland, Labrador, and southern Greenland, the station at Belle Isle, Newfoundland, averaging 0.11 inch deficient. Both the Azores HIGH area and the Icelandic LOW were displaced to westward of their usual April positions.

There were considerable fluctuations of pressure during the month. The northwestern and north-central portions experienced quite low pressure about the 10th to 18th, but in contrast the region from Bermuda to the Azores had high pressure from the 12th to 18th. Around the British Isles low pressure during the first 8 days was followed by somewhat irregular conditions, but with rather high pressure prevailing about the 18th and again during the final 5 days of the month.

The extremes of pressure in the vessel reports at hand were 30.66 and 28.47 inches, both noted near the British Isles. The high mark was reached within a few miles of the southwest coast of Ireland, about noon of the 19th, the vessel being the British steamship *Montreal City*. An unidentified vessel radioed the report of the lowest reading from near 52° N., 22° W., late on the forenoon of the 3d.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, April 1939*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.73	−0.10	30.10	4	29.10	14
Reykjavik, Iceland	29.82	+.02	30.36	30	29.21	15
Lerwick, Shetland Islands	29.83	+.03	30.53	29	29.09	15
Valencia, Ireland	29.92	+.03	30.62	19	28.91	4
Lisbon, Portugal	30.04	+.05	30.39	15	29.59	5
Madeira	[1] 30.02	+.01	30.24	14	29.80	4
Horta, Azores	30.08	−.07	30.46	14	29.78	3, 4
Belle Isle, Newfoundland	29.78	−.11	30.40	22	29.08	16
Halifax, Nova Scotia	29.92	−.01	30.40	18	29.46	30
Nantucket	29.93	−.04	30.50	17	29.33	2
Hatteras	30.00	−.01	30.47	14	29.60	29
Bermuda	30.14	+.05	30.36	15	29.64	29
Turks Island	30.05	+.03	30.14	14	29.89	4
Key West	30.02	.00	30.23	14	29.86	29
New Orleans	30.02	+.02	30.41	13	29.72	6

[1] For 25 days.

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—All sections considered, there was about the usual storm activity for April over the North Atlantic. The first 5 days included numerous gale reports from the eastern part of the chief steamship lanes to northwestern Europe, but that region was nearly free from vigorous storms during the remainder of the month. The central and western portions of the North Atlantic were most affected by strong LOWS about the 7th to 11th and during the final 5 days.

When April began, two storm centers were between the southern Grand Banks and the British Isles, near the fifteenth and fortieth meridians, respectively. By the evening of the 2d these had coalesced near 53° N., 22° W., and a very intense LOW was the result. For more than a day there was no marked change, but high pressure prevailed at the time over Greenland and the LOW presently moved a moderate distance toward the east-southeast with some loss of strength, then it lengthened toward the northeast and separated into two cyclones, each much weaker than the single storm had been; so by the evening of the 6th scarcely any strong winds remained in the region. The German liner *Columbus* had reported force 11 in connection with this cyclonic system, and another vessel noted force 10.

The next instance of force-11 wind likewise was from the *Columbus*, the day being the 7th and the location near 41° N., 63° W., and about the same time the American steamship *Exiria* noted force 10 when about 300 miles to southward of this position. At the time a cyclone was centered to northwestward of the Gulf of St. Lawrence, with a narrow extension toward the southeast and south; but this center quickly ceased to affect the much traveled sections of the ocean.

Soon afterward much of the western Atlantic was under the influence of another LOW, which was off the Carolina coast on the 8th, not yet well developed, but on the 9th was a short distance south of Nova Scotia and comparatively strong. Continued advance toward the northeast had brought the center by the 11th and the forenoon of the 12th to about 52° N., 32° W., with great intensity. The lone report of hurricane wind from the North Atlantic this month was connected with this LOW, the vessel being the Norwegian motor tanker *Britannia*.

During the latter part of the 12th and all of the 13th the center moved northeastward, losing force. On the whole, the period from the 13th to 22d was a quiet one for April over the Atlantic. In the western Gulf of Mexico, however, there was a brief encounter with intense winds on the 16th, when the American tanker *Eastern Sun* noted strong-gale force; there was at this time a cyclonic system of marked extent from central Canada southward to the western Gulf, and the vessel met the high winds in the southern part of the storm area.

About the 27th, by the uniting of moderately strong cyclones near mid-Atlantic, a strong LOW formed and was felt over a large area on that day and the next, the *American Merchant* meeting storm-force winds. As this LOW weakened, other centers, advancing from the North American Continent, caused gales over the portion west of the fifty-fifth meridian, though no force greater than 10 there has yet been reported. This group of LOW centers was still quite strong when the month ended.

Fog.—There was decided contrast in the parts of the month when fog was met most frequently over different North Atlantic areas. In the general vicinity of the

Grand Banks it was much more prevalent after the 17th of the month than before and this was even more notably the case near the coast of the American Continent from Nova Scotia to Virginia. Near 50° N., 35° W., the comparatively few reports of fog indicate its occurrence only during the first 9 days; while to northward and northeastward of the Azores fog was noted only about the 16th and the 30th.

Over most of the North Atlantic fog was less common than usual in April. In particular a large region extending for several hundred miles to westward and southwestward of Ireland has yielded scarcely a single report of fog, though numerous vessels have furnished weather observations for this much traversed region.

The leading square for fog frequency was that from 40° to 45° N., 45° to 50° W., where there were 12 days. Close to the coast of the United States no other square equaled that from 35° to 40° N., 70° to 75° W., where the count was 7 days. As a rule, from the eastern limits of the Grand Banks to Cape Cod there was an increase in amount of fog from March to April, and from Cape Cod to Hatteras there was about the same amount as during March. In the Gulf of Mexico there was almost complete absence of fog during April, only two reports coming from the entire Gulf area.

From the vicinity of the Guinea coast, about 9° N., 16° W., where fog is very seldom met, there has been received the statement that a thin fog patch was traversed by a north-bound steamship on the 10th.

Two collisions due to fog occurred near Sandy Hook. The earlier, on the 19th, resulted in considerable damage, but both vessels easily made port. The other collision, on the 27th, led to the sinking of a pilot boat, but without loss of life.

OCEAN GALES AND STORMS, APRIL 1939

Vessel	Voyage		Position at time of lowest barometer		Gale began April	Time of lowest barometer, April	Gale ended April	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Seanmail, Am. S. S.	New York	Copenhagen	49 48 N.	35 30 W.	[3] 30	3a, 1	1	29.55	NW	W, 7	W	WNW, 9	
Flora, Du. S. S.	do	La Guaira	35 48 N.	73 48 W.	1	10p, 1	2	29.67	SSW	WSW, 9	W	WSW, 9	SW-W.
Binnendyk, Du. S. S.	Rotterdam	Boston	[1] 46 47 N.	29 59 W.	3	4a, 3	4	29.15	WNW	WNW, 7	NNW	NW, 9	None.
Europa, Ger. S. S.	Cherbourg	New York	47 38 N.	26 40 W.	3	2p, 3	4	28.53	WSW	W, 9	NW	NW, 10	WSW-NW.
Columbus, Ger. S. S.	Gibraltar	do	40 18 N.	21 54 W.	3	5p, 3	4	29.42	W	W, 7	WNW	WNW, 11	WSW-W.
Pres. Harding, Am. S. S.	Cobh	do	48 24 N.	28 24 W.	3	10p, 3	4	29.69		NNW, 8	NNW	NNW, 8	WSW-NNW.
West Kyska, Am. S. S.	Antwerp	Georgetown, S. C.	[1] 43 20 N.	24 34 W.	3	Mdt, 3	4	29.07	WNW	NW, 9	NW	NW, 9	W-NW.
American Farmer, Am. S. S.	London	New York	46 52 N.	22 02 W.	4	3a, 4	4	28.57	W	SW, 6	NW	WNW, 9	SW-W.
Spaarndam, Du. S. S.	Antwerp	New Orleans	42 28 N.	40 17 W.	2	4a, 4	4	29.08	S	W, 8	WNW	W, 8	None.
Schuylkill, Br. M. S.	Aruba	Liverpool	41 02 N.	29 17 W.	2	1p, 4	5	29.65	WNW	NW, 8	NNW	NNW, 9	
Exiria, Am. S. S.	Lisbon	New York	35 40 N.	56 30 W.	6	7a, 6	6	29.67	WNW	WNW, 7	NW	WNW, 8	W-NW.
American Farmer, Am. S. S.	London	do	[1] 42 39 N.	40 35 W.	7	—p, 6	7	29.48	WNW	SSW, 6	NW	WNW, 9	SSW-W.
Britannia, Nor. M. S.	Port Arthur	Liverpool	39 20 N.	64 42 W.	6	2a, 7	7	29.77	S	S, 9	NW	S, 9	S-SW.
Collamer, Am. S. S.	New York	Havre	44 04 N.	42 22 W.	7	6a, 7	8	29.40	WNW	WNW, 7	WNW	NW, 10	WNW-NW.
Exmoor, Am. S. S.	do	Casablanca	35 55 N.	34 26 W.	6	Noon, 7	8	30.08	S	S, 8	W	W, 8	S-W.
Black Gull, Am. S. S.	do	Antwerp	40 59 N.	62 49 W.	7	Noon, 7	7	29.81	SSE	SSW, 8	SSW	SSW, 9	SSE-SSW.
Emile Francqui, Belg. S. S.	Antwerp	New York	42 43 N.	44 14 W.	7	2p, 7	7	29.67	SW	NW, 8	NW	NW, 9	
Columbus, Ger. S. S.	Gibraltar	do	40 36 N.	62 56 W.	7	2p, 7	7	29.74	SSE	SW, 11	W	SW, 11	SSW-WNW.
Exiria, Am. S. S.	Lisbon	do	35 50 N.	62 00 W.	7	4p, 7	9	29.53	SSW	W, —	NW	SSW, 10	
Knoxville City, Am. S. S.	Cristobal	London	49 14 N.	9 57 W.	8	Noon, 9	9	[2] 29.53	S	SSE, 8	SSE	S, 8	None.
Emile Francqui, Belg. S. S.	Antwerp	New York	41 00 N.	55 36 W.	9	4p, 9	10	29.31	WSW	SW, 5	NW	W, 8	SSW-WSW.
American Farmer, Am. S. S.	London	do	41 12 N.	56 20 W.	9	4p, 9	10	29.45	SSW	SSW, 9	WNW	SW, 10	SSW-W.
Washington, Am. S. S.	Cobh	do	44 32 N.	40 53 W.	10	Noon, 11	11	29.24	W	W, 10	NW	W, 10	W-WNW.
Britannia, Nor. M. S.	Port Arthur	Liverpool	44 22 N.	44 31 W.	10	Noon, 11	12	29.45	WNW	WNW, 11	NW	NW, 12	WNW-NW.
James McGee, Am. S. S.	Cartagena	Havre	40 00 N.	39 00 W.	11	4p, 11	12	29.71	W	WNW, 8	NW	WNW, 8	WNW-W.
Black Gull, Am. S. S.	New York	Antwerp	47 02 N.	31 55 W.	10	Mdt, 11	11	28.87	W	WSW, 7	SW	WSW, 9	SW-W.
Eastern Sun, Am. M. S.	Beaumont	Marcus Hook	29 28 N.	93 20 W.	16	4p, 16	16	29.71	S	SSW, 9	SW	SSW, 9	S-SW.
San Jose, Fr. S. S.	Havre	New York	41 11 N.	44 44 W.	16	11p, 16	16	30.08	SSW	NW, 7	SSW	SSW, 8	SSW-NW-WNW.
Excalibur, Am. S. S.	Gibraltar	Boston	40 30 N.	36 10 W.	19	8a, 19	20	29.64	N	N, 10	N	N, 10	SSE-NW-N.
Svanhild, Dan. S. S.	Aalborg	New York	57 20 N.	8 30 W.	19	8p, 19	19	30.15	SW	NW, 5	NW	SW, 9	WSW-NW.
San Jose, Fr. S. S.	Havre	do	40 42 N.	64 08 W.	19	6a, 20	20	30.04	S	S, 9	SSW	S, 10	S-SW.
Clydefield, Br. M. S.	Las Piedras	Sheerness	36 38 N.	37 42 W.	19	10a, 20	20	29.46	N	NNW, 9	NNE	NNW, 9	NNW-NE.
Svanhild, Dan. S. S.	Aalborg	New York	55 46 N.	26 36 W.	22	4p, 23	24	29.87	W	NNW, 10	NNW	NNW, 10	WNW-NNW.
Jouett, U. S. N.	Chatham, England.	Norfolk	38 46 N.	56 13 W.	24	2p, 24	24	29.93	SW	NW, 9	W	NW, 9	SW-NW.
Black Gull, Am. S. S.	Rotterdam	New York	44 00 N.	40 40 W.	27	4a, 27	27	29.04	NNW	NNW, 10	NW	NW, 10	ENE-NNW.
American Merchant, Am. S. S.	London	do	44 37 N.	40 33 W.	27	8a, 27	27	29.00	WNW	WNW, 8	WNW	W, 11	ESE-WNW-NNW.
Patrick Henry, Am. S. S.	New Orleans	Havre	39 59 N.	48 50 W.	27	4a, 28	28	29.55	SSE	SW, 8	WNW	SW, 8	S-W.
American Merchant, Am. S. S.	London	New York	41 12 N.	57 36 W.	30	9p, 29	30	29.60	S	E, 5	NW	S, 8	ENE-S.
Black Gull, Am. S. S.	Rotterdam	do	41 24 N.	59 48 W.	30	10a, 30	30	29.06	SW	SW, 10	W	W, 10	SW-W.
Zarembo, Am. S. S.	St. Vincent, C. V. I.	Boston	35 48 N.	59 18 W.	30	4p, 30	30	29.61	SW	SW, 8	W	SW, 8	SW-W.
NORTH PACIFIC OCEAN													
Sanyo Maru, Jap. M. S.	Yokohama	Los Angeles	43 30 N.	162 31 E.	4	4a, 4	5	29.88	SE	SE, 9	S	SE, 9	SE-SSE.
Silvermaple, Br. M. S.	Manila	Portland, Ore.	39 52 N.	158 43 E.	3	4a, 4	4	29.61	S	S, 9	NW	S, 9	SSE-SSW.
Naruto Maru, Jap. M. S.	Yokohama	Los Angeles	42 10 N.	154 55 W.	4	6a, 5	5	29.07	NNE	NNE, 8	W	NNE, 9	NNE-W.
Empress of Russia, Br. S. S.	Victoria	Yokohama	[1] 48 33 N.	169 06 E.	8	Mdt, 8	9	29.60	W	WSW, 8	W	WNW, 9	WSW-WNW.
Sanyo Maru, Jap. M. S.	Yokohama	Los Angeles	45 12 N.	152 50 W.	9	2a, 9	9	29.17	S	SSW, 8	W	SW, 9	S-SW.
Hikawa Maru, Jap. M. S.	do	Vancouver, B. C.	49 55 N.	148 42 W.	9	Noon, 9	9	28.84		S, 7		SSW, 9	
Hoyo Maru, Jap. M. S.	San Francisco	Sasebo	50 06 N.	179 48 W.	11	7a, 10	11	28.35	NW	ESE, 4	WSW	W, 11	ESE-Var-NW.
Oregonian, Am. S. S.	do	Portland, Ore.	37 48 N.	122 54 W.	13	4a, 13	13	29.85	NW	WNW, 6	NNW	NNW, 8	WNW-NW.
Marchen Maersk, Dan. M. S.	Yokohama	Los Angeles	44 54 N.	171 54 W.	16	Noon, 16	16	29.94		S, 8		S, 8	SE-S.
Pres. Harrison, Am. S. S.	San Francisco	Honolulu	31 48 N.	139 05 W.	18	5p, 18	18	29.72	S	SSW, 8	SW	SSW, 8	S-SW.
Empress of Asia, Br. S. S.	Honolulu	Victoria, B. C.	38 15 N.	141 00 W.	16	2a, 18	18	29.98	NNE	NE, 9	E	NE, 9	NE-ENE.
Corneville, Nor. M. S.	Hong Kong	Los Angeles	35 26 N.	145 12 W.	18	2a, 19	19	29.82	N	NE, 9	NE	N, 10	N-NE.
Washington, Am. S. S.	Shanghai	Portland, Ore.	47 00 N.	154 30 W.	24	2a, 26	26	29.56	WNW	NW, 8	NW	NW, 8	
City of Dalhart, Am. S. S.	Hong Kong	Los Angeles	34 01 N.	150 50 E.	27	8p, 27	27	29.65	SE	SSE, 8	S	SSE, 8	SE-SSW.

[1] Position approximate. [2] Barometer uncorrected. [3] March.

NORTH PACIFIC OCEAN, APRIL 1939

By WILLIS E. HURD

Atmospheric pressure.—In April 1939 the Aleutian LOW as an average extended from the western part of the Gulf of Alaska across the Bering Sea and the western Aleutians to the Asiatic coast, with the lowest average land station pressure, 29.64 inches, at Petropavlosk, departure from the normal, —.16. The lowest pressures of the month, 28.20 to 28.30 inches, occurred over and immediately south of the central Aleutians on the 10th and 11th.

In middle latitudes there was a considerable prevalence of anticyclones, with the average HIGHS central from Vancouver southwestward to about the one hundred and fiftieth meridian of west longitude and in the vicinity of Midway Island. At Tatoosh Island and Midway Island, land stations representative of these HIGHS, the respective average pressures were 30.13 and 30.21, which were +.13 and +.09 above the month's normals.

In tropical latitudes pressures were about normal. The Asiatic HIGH, prevalent in the colder months, had disappeared in April of this year from the far eastern waters.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, April 1939, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.87	−0.21	30.64	2	29.20	18
Dutch Harbor	29.86	+.08	30.82	1	28.56	11
St. Paul	29.73	−.06	30.62	3	28.56	11
Kodiak	29.74	−.01	30.58	4	28.82	25
Juneau	29.98	+.02	30.72	5	28.95	25
Tatoosh Island	30.13	+.13	30.61	5	29.72	3
San Francisco	30.05	.00	30.27	4	29.86	13
Mazatlan	29.86	−.03	29.92	9, 15	29.80	5
Honolulu	30.04	−.02	30.17	23	29.84	4
Midway Island	30.21	+.09	30.36	6	29.89	3
Guam	29.85	−.04	29.89	1, 20, 30	29.77	22
Manila	29.85	+.03	29.97	26	29.71	16
Hong Kong	29.89	+.01	30.19	5, 6	29.70	19
Naha	29.90	−.02	30.21	6	29.74	15
Titijima	29.99	+.02	30.33	28	29.72	27
Petropavlosk	29.64	−.16	30.27	24	28.73	2

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—Although there were regions of local storminess, in both east and west longitudes of the North Pacific, the month and ocean as a whole cannot be considered as more than moderately stormy. Aside from a number of scattered winds of force 7, which in some LOWS were the highest reported, the strongest winds of the month were rarely higher in force than 8 or 9, the principal exception being a gale of force 11 encountered near the central Aleutians on the 11th.

Early in the month there were two gale-producing cyclones. One extended as a long trough from the western part of the Bering Sea southward into middle latitudes, causing fresh gales at stations north of the main traveled routes on the 2d and 3d, and strong southerly gales (force 9) within the region 40° to 45° N., 155° to 165° E., on the 4th. The other cyclone originated on the 1st to the northward of the Hawaiian Islands and entered the Gulf of Alaska on the 7th. It resulted in fresh gales in the area of about 35° to 40° N., 155° to 165° W., on the 3d, and gales of force 9 farther northward on the 5th.

On the 8th and 9th two rather active LOWS affected half the width of the ocean in higher latitudes. These caused fresh to strong gales in both east and west longitudes along the middle portions of the northern steamer routes. On the 10th and 11th the westernmost of the LOWS developed strongly over and south of the central Aleutians, resulting in pressures well below 28.50 inches over a considerable area, and in some local gales, the strongest of which, a west wind of force 11, barometer 28.35, was experienced by the Japanese motorship *Hoyo Maru* near 50° N. and the 180th meridian, on the 11th.

A very small LOW began to develop in the midst of a general high pressure area over the eastern part of the ocean on the 17th. Its shallow center on that date was near 36° N., 144° W. Local gales of force 8 accompanied its formation. On the 18th, as the little disturbance slowly increased in wind intensity, northerly gales of force 9 to 10, with barometric readings only a little lower than 30 inches, occurred within the region 30° to 35° N., 140° to 146° W. The LOW deteriorated on the 19th.

From the 19th until the end of the month there were no storm areas of importance, and such few gales as were reported were only of isolated occurrence.

In American coastal waters one gale occurred. This was on the 13th and was reported, of force 8 from the north-northwest, by the American S. S. *Oregonian* just outside the Golden Gate. A LOW at the time lay over California and the immediate coast, with an anticyclone pressing close in from the westward.

Fog.—Along the northern routes there was less fog in April than in the preceding month, and the occurrences were scattering. The principal area of fog in open ocean was the latitudinal strip 30° to 35° N., between longitudes 155° and 175° E., with 9 days having fog. Along the American coast a fog belt extended from Oregon to Cape San Lucas. Five days were reported with fog off Oregon; 10, off California; and 7, off Lower California.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

TABLE 1.—*Condensed climatological summary of temperature and precipitation by sections, April 1939*

[For description of tables and charts, see REVIEW, January, p. 31]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	62.7	−0.9	Tuskegee	89	11	3 stations	28	8	3.52	−0.98	Columbia	7.39	Eutaw	1.14
Arizona	60.8	+2.3	Mohawk	107	21	2 stations	10	15	.56	−.07	Sierra Ancha	2.43	8 stations	.00
Arkansas	59.3	−2.1	2 stations	91	26	Lead Hill	19	7	7.13	+2.29	Pine Ridge	13.42	Crossett	2.89
California	58.9	+2.7	Brawley	106	21	South Lake	13	15	.52	−1.10	Santa Ana River	5.00	6 stations	.00
Colorado	46.0	+2.3	2 stations	93	[1] 22	Spicer	−11	6	.91	−.83	Hawthorne	3.29	4 stations	.00
Florida	70.7	+.8	Avon Park	97	17	2 stations	34	9	4.32	+1.43	Tallahassee	9.25	Chapman Field Garden	.91
Georgia	62.7	−.6	Fargo	89	[1] 18	Blairsville	24	8	3.65	−.20	Fargo	7.53	Macon	1.44
Idaho	47.8	+2.7	Lewiston	98	28	Blackfoot Dam	−1	6	.68	−.73	Preston	1.97	Payette	.00
Illinois	49.6	−2.7	2 stations	86	24	Marengo	13	8	5.01	+1.50	Mount Carmel	8.23	Waukegan	1.76
Indiana	48.8	−3.0	Madison	92	24	5 stations	18	[1] 12	5.80	+2.26	Vevak	8.58	Albion	1.46
Iowa	47.8	−.9	Boone	93	24	Forest City	10	12	2.07	−.65	Donnellson	5.80	Omaha (Nebr.)	.64
Kansas	54.5	−.2	Alton (near)	98	23	Colby	13	6	1.96	−.56	Lawrence	5.59	Lakin	.11
Kentucky	53.7	−2.5	Calhoun	91	24	Annville	21	13	6.07	+2.11	Paducah (near)	9.43	Williamstown	2.77
Louisiana	66.0	−1.0	2 stations	90	[1] 11	2 stations	29	8	2.40	−2.22	Port Sulphur	6.06	Lake Arthur	.80
Maryland-Delaware	51.3	−.5	Leonardtown, Md.	93	25	do	16	[1] 8	5.15	+1.70	2 stations	7.10	Mount Savage, Summit, Md.	3.44
Michigan	39.9	−2.2	Eloise	89	26	Dukes	−8	9	2.74	+.29	Michigamme	5.64	St. Ignace	.44
Minnesota	40.4	−2.6	Albert Lea	91	24	Hallock	−3	11	1.45	−.64	Maple Plain	3.09	Ah-gwah-ching	.02
Mississippi	62.6	−1.9	Magnolia	89	2	Pontotoc	30	8	3.89	−.99	Hernando	10.15	Brookhaven	1.42
Missouri	53.4	−1.8	4 stations	88	[1] 23	Goodland	16	7	5.01	+1.08	Salem	8.21	Neosho	2.22
Montana	45.8	+2.7	Winifred	97	29	Summit	−10	6	.78	−.33	Summit	2.40	White Water	.07
Nebraska	49.5	+.3	3 stations	98	23	Sidney	7	6	1.40	−.97	Fairbury	4.03	Hull (near)	.31
Nevada	52.0	+4.0	Las Vegas Airport	97	22	San Jacinto	11	6	.79	+.02	Eureka	3.12	Imlay	.00
New England	40.3	−3.4	2 stations	87	25	First Conn. Lake, N. H.	−5	8	4.56	+1.20	Hoosac Tunnel, Mass.	7.00	Fort Kent, Maine	2.05
New Jersey	48.3	−1.4	do	89	25	Layton	20	[1] 8	5.12	+1.51	Camden	6.61	Sandy Hook	3.44
New Mexico	52.8	+1.3	do	95	[1] 3	3 stations	5	[1] 5	.88	+.02	Lake Alice (near)	2.74	4 stations	.00
New York	41.7	−2.5	Bedford Hills	90	25	North Lake	2	10	3.36	+.37	West Point	6.18	Gabriels	1.14
North Carolina	58.0	+.1	Kinston	92	27	Mount Mitchell	6	13	3.48	−.14	Highlands	6.81	Gastonia	1.47
NorthDakota	41.6	+.2	3 stations	90	30	2 stations	−1	11	.87	−.54	Parshall	2.13	Howard	.32
Ohio	47.1	−2.6	Ironton	89	24	3 stations	18	[1] 5	5.00	+1.83	West Union	9.61	Upper Sandusky	2.38
Oklahoma	59.8	−.5	Lawton	98	26	Kenton	18	6	2.44	−.86	Hugo	9.34	Lawton	.18
Oregon	50.2	+3.0	La Grande	95	28	Austin	10	14	.44	−1.54	Seaside	3.11	2 stations	.00
Pennsylvania	46.7	−1.9	Stroudsburg	90	25	2 stations	9	9	3.70	+.27	Phila. Navy Yard	6.83	Galeton	1.16
South Carolina	62.4	+.1	Conway	91	27	Caesars Head	25	13	3.15	−.01	Caesars Head	6.17	Georgetown	1.70
South Dakota	46.1	+.3	2 stations	95	23	Pollock	3	12	1.03	−1.01	Harveys Ranch	4.79	Dupree	.23
Tennessee	56.6	−2.0	Loudon	90	24	Rugby	21	8	4.92	+.48	Brownsville	9.39	Elizabethton	2.09
Texas	66.6	+.5	3 stations	105	2	Mount Locke	17	6	1.47	−1.56	Arthur City	7.53	6 stations	.00
Utah	50.7	+3.6	St. George	92	28	Silver Lake	0	6	.78	−.38	Ogden	3.15	Moab	.00
Virginia	53.9	−.6	3 stations	92	25	Mountain Lake	11	13	3.15	−.19	Wallaceton	5.17	Radford	1.16
Washington	50.6	+2.4	do	93	28	Mount Baker Lodge	15	4	.91	−1.43	Forks	5.23	2 stations	.00
West Virginia	49.9	−1.8	Hinton	92	24	Bayard	12	8	5.36	+1.81	Greenbottom	8.81	Union	1.59
Wisconsin	40.8	−2.8	Prairie du Chien	88	24	Laona	−4	8	2.29	−.25	Lancaster	3.58	Bayfield	.70
Wyoming	43.7	+3.5	3 stations	90	29	Dome Lake	−12	11	.96	−.60	Dome Lake	4.45	Rawlins	.04
Alaska (March)	10.8	−2.6	Coal Creek	60	28	Allakaket	−47	19	1.87	+.06	Latouche	18.91	Barrow	T
Hawaii	69.9	+.1	Kaanapali	91	11	Kanalohuluhulu	42	2	12.76	+4.49	Puu Kukui (upper)	50.00	Puu Ulaula	1.46
Puerto Rico	73.7	−1.1	Manati	95	30	Utuado	50	3	3.20	−1.01	Rio Blanco (1,800 ft.)	12.35	Santa Rita	.00

[1] Other dates also.

TABLE 2.—*Climatological data for Weather Bureau Stations, April 1939*

[Compiled by Annie E. Small, by official authority U. S. Weather Bureau]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	° *F.*	° *F.*	°*F.*		°*F.*	° *F.*		°*F.*	° *F.*	° *F.*	° *F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							**41.9**	**−2.1**										**74**	**4.36**	**+1.3**										**6.8**		
Eastport	75	67	85	29.82	29.91	−0.02	37.6	−1.4	58	20	44	22	16	32	24	34	30	78	3.95	+1.1	14	10.3	nw.	47	e.	2	5	7	18	7.0	11.6	0.0
Greenville, Me	1,069	4	41	28.70	29.93	.....	33.8	.....	56	21	43	4	10	25	46	30	26	...	3.96	.....	17	.....	nw.	.....	.....	.....	.....	.....	.....	.....	23.7	4.0
Portland, Me	103	82	117	29.81	29.93	−.03	40.6	−2.4	61	22	47	27	10	34	21	35	29	69	5.79	+2.4	16	8.4	w.	34	ne.	2	9	8	13	5.9	6.5	.0
Concord	289	54	72	29.60	29.92	−.07	40.8	−2.6	69	25	50	20	10	32	34	.....	.....	...	4.22	+1.4	16	6.3	w.	20	nw.	7	6	10	14	7.0	5.3	.0
Burlington	403	11	48	29.46	29.91	−.08	38.0	−5.3	60	26	45	20	16	31	25	34	30	76	4.21	+2.1	17	8.9	s.	32	s.	6	3	10	17	7.5	16.2	.0
Northfield	876	12	60	28.96	29.93	−.06	35.7	−4.6	59	25	44	13	10	27	33	33	28	75	3.87	+1.6	16	7.1	sw.	27	s.	8	2	11	17	7.7	13.7	.0
Boston [1]	29	33	62	29.89	29.92	−.05	43.6	−2.8	69	22	50	26	13	37	24	38	32	70	4.54	+1.2	14	11.4	w.	34	e.	2	2	8	20	7.7	.2	.0
Nantucket	12	14	90	29.91	29.93	−.04	44.0	+.6	58	22	50	30	13	38	17	40	37	80	3.52	+.6	11	15.5	w.	43	sw.	2	8	12	10	5.8	.7	.0
Block Island	26	11	46	29.90	29.93	−.05	43.8	−.2	60	22	50	31	5	38	17	41	37	80	3.99	+.5	14	16.4	w.	45	w.	2	12	5	13	6.0	T	.0
Providence	159	215	251	29.75	29.93	−.05	45.4	−1.2	71	25	54	27	13	37	31	40	35	72	4.33	+1.1	14	12.0	nw.	45	nw.	2	4	11	15	6.8	T	.0
Hartford	159	66	100	29.75	29.93	−.06	45.4	−1.3	81	25	54	27	13	37	35	.....	.....	...	4.37	+1.0	14	9.0	nw.	32	nw.	2	5	12	13	6.7	1.0	.0
New Haven	106	74	153	29.82	29.94	−.05	45.8	−1.4	67	23	53	28	13	39	28	40	34	66	5.14	+1.6	15	9.9	n.	27	sw.	23	6	10	14	6.7	.2	.0
Middle Atlantic States							**50.5**	**−0.9**										**67**	**3.83**	**+0.8**										**6.3**		
Albany [1]	292	26	40	29.61	29.93	−.07	42.1	−4.7	80	25	51	22	8	33	38	37	32	72	3.48	+1.0	18	10.4	s.	33	nw.	4	1	9	20	8.0	6.3	.0
Binghamton	871	57	79	28.99	29.94	−.08	44.6	−.8	85	25	54	24	12	36	41	39	33	70	2.44	.0	19	7.3	nw.	21	nw.	12	1	8	21	8.5	1.4	T
New York	314	415	454	29.59	29.93	−.07	47.8	−1.6	83	25	55	27	13	41	32	42	35	64	3.90	+.7	15	15.6	nw.	56	nw.	12	4	11	15	6.8	T	.0
Harrisburg [1]	374	94	104	29.58	29.96	−.06	48.6	−2.3	86	25	58	28	13	39	39	42	36	66	2.79	+.1	15	10.0	nw.	34	sw.	11	2	12	16	7.4	T	.0
Philadelphia	114	174	367	29.83	29.96	−.05	50.4	−1.7	85	25	58	29	13	42	28	44	39	70	6.40	+3.4	15	13.4	nw.	40	s.	6	4	14	12	6.4	T	.0
Reading	323	283	306	29.60	29.96	.....	49.0	−1.3	84	25	58	28	13	40	30	42	36	64	3.27	.0	16	13.2	nw.	42	nw.	12	4	13	13	6.8	.1	.0
Scranton	805	72	104	29.06	29.93	−.08	45.8	−2.3	84	25	55	25	13	37	38	40	34	68	3.30	+.5	18	7.4	nw.	28	nw.	12	1	11	18	7.3	.5	.0
Atlantic City	52	37	172	29.90	29.96	−.04	49.0	−1.2	79	25	55	30	5	43	25	44	39	73	5.78	+2.8	17	18.3	w.	44	w.	12	7	10	13	6.4	T	.0
Sandy Hook	22	10	57	29.91	29.94	.....	47.2	−1.1	83	25	53	31	13	41	31	43	38	75	3.44	−.2	15	14.8	w.	48	nw.	12	5	10	15	6.7	T	.0
Trenton	190	89	107	29.74	29.94	.....	49.0	+1.2	85	25	58	28	13	40	31	42	36	66	5.31	+2.4	15	10.2	w.	30	w.	12	3	13	14	7.0	.3	.0
Baltimore	123	100	215	29.83	29.96	−.05	53.4	−.2	89	25	62	32	13	45	31	45	37	60	5.92	+2.6	14	12.0	sw.	40	sw.	12	10	6	14	6.1	T	.0
Washington	112	62	85	29.84	29.96	−.06	53.4	+.1	90	25	63	31	13	44	39	46	38	62	3.78	+.5	15	8.3	nw.	26	nw.	12	10	7	13	6.0	T	.0
Cape Henry	18	8	54	29.96	29.97	.....	57.3	+2.7	87	25	66	38	13	49	32	52	49	77	3.96	+.7	11	13.9	sw.	45	n.	30	14	8	8	4.6	.0	.0
Lynchburg	686	144	184	29.25	29.99	−.03	55.2	−2.1	87	24	67	31	14	44	40	47	40	62	2.80	−.2	13	9.3	sw.	32	nw.	30	12	9	9	4.7	.0	.0
Norfolk	91	80	125	29.89	29.99	−.02	58.8	+2.0	87	25	68	36	13	49	30	50	44	66	4.26	+1.0	12	11.8	sw.	33	w.	1	12	9	9	5.3	.0	.0
Richmond	144	11	52	29.83	29.98	−.04	56.8	+.2	87	25	68	33	14	46	36	48	42	65	3.00	−.5	14	10.3	sw.	32	sw.	1	13	7	10	4.9	.0	.0
Wytheville	2,304	49	55	27.58	29.99	−.04	50.2	−1.8	82	24	62	25	5	39	42	43	36	63	1.30	−1.7	12	8.5	w.	26	w.	30	10	10	10	5.0	T	.0
South Atlantic States							**62.6**	**+0.7**										**66**	**2.69**	**−0.3**										**4.5**		
Asheville	2,253	89	104	27.66	30.02	−.01	54.1	+.2	81	24	65	28	13	43	40	45	38	61	2.38	−.6	10	10.7	nw.	27	se.	17	10	10	10	4.9	.0	.0
Charlotte	779	63	86	29.19	30.01	−.02	60.0	+.2	84	27	71	35	13	49	33	50	42	57	1.69	−1.6	8	8.9	sw.	30	sw.	6	10	12	8	4.8	.0	.0
Greensboro [1]	886	6	56	29.06	30.01	.....	55.7	.....	83	15	68	28	5	44	38	48	41	66	2.77	.....	11	10.0	sw.	37	ne.	29	13	11	6	4.2	.0	.0
Hatteras	11	5	50	30.00	30.00	−.01	61.4	+1.6	77	27	68	41	13	55	23	56	53	77	3.08	−.5	10	14.5	sw.	36	w.	1	15	7	8	4.5	.0	.0
Raleigh	376	103	140	29.59	29.99	−.04	60.0	+.6	86	24	71	35	13	49	35	52	45	66	3.57	+.1	8	10.5	sw.	30	nw.	17	14	10	6	4.1	.0	.0
Wilmington	72	73	107	29.95	30.02	−.01	62.4	+.4	84	27	71	41	5	54	31	56	51	72	1.82	−.8	9	11.2	sw.	34	s.	6	17	6	7	3.9	.9	.0
Charleston	48	11	92	29.99	30.04	+.01	66.0	+1.5	90	27	74	46	9	58	27	58	54	71	2.05	−.5	10	10.8	s.	31	s.	6	13	11	6	4.6	.0	.0
Columbia, S. C	347	70	91	29.64	30.02	−.01	63.8	+.5	85	27	74	40	13	53	31	53	46	60	2.18	−.7	10	9.6	s.	31	sw.	6	17	10	3	3.5	.0	.0
Greenville, S. C	1,040	70	78	28.90	30.00	.....	59.8	+1.2	84	27	71	36	13	49	32	50	41	56	3.24	−.5	8	8.8	sw.	27	sw.	6	11	12	7	4.7	.0	.0
Augusta	182	62	77	29.81	30.01	−.02	64.2	.0	85	16	76	41	14	53	35	55	47	62	3.07	−.1	10	6.7	nw.	24	sw.	11	13	12	5	4.2	.0	.0
Savannah	65	73	152	29.96	30.02	−.01	67.4	+1.4	88	27	77	46	9	58	30	59	55	73	1.90	−.7	7	11.4	sw.	32	nw.	6	14	8	8	4.5	.0	.0
Jacksonville	43	86	110	30.00	30.05	+.01	69.3	+.6	87	27	79	47	9	60	28	61	56	72	4.62	+2.2	9	8.6	sw.	30	sw.	1	7	15	8	5.6	.0	.0
Florida Peninsula							**75.2**	**+2.0**										**75**	**3.27**	**+1.2**										**4.5**		
Key West	21	10	64	29.99	30.02	.00	76.9	+1.2	87	28	83	64	9	71	19	70	68	77	7.46	+6.2	12	10.3	se.	31	nw.	8	14	9	7	4.5	.0	.0
Miami	25	124	168	30.02	30.05	+.02	75.6	+2.8	89	28	81	49	9	70	29	68	65	72	1.19	−1.9	4	10.7	se.	31	sw.	8	13	10	7	5.0	.0	.0
Tampa	35	88	197	30.01	30.04	−.02	73.0	+2.1	87	27	82	52	9	64	26	65	62	77	1.17	−.8	7	11.0	nw.	30	s.	6	16	9	5	3.9	.0	.0
East Gulf States							**64.2**	**−0.7**										**68**	**3.52**	**−0.6**										**5.0**		
Atlanta [1]	976	5	72	28.99	30.01	−.02	60.1	−.9	82	15	72	36	7	48	34	51	44	64	2.36	−1.2	11	11.3	nw.	37	nw.	28	13	6	11	4.8	.0	.0
Macon	370	79	87	.....	30.03	.00	63.2	−.7	83	27	75	41	13	52	34	.....	.....	62	1.44	−1.7	12	8.1	nw.	29	s.	11	12	9	9	.....	.0	.0
Thomasville	273	49	58	29.75	30.05	+.02	66.6	−.1	84	27	78	44	8	56	30	59	54	...	7.14	+3.8	10	.....	sw.	.....	.....	.....	13	11	6	4.8	.0	.0
Apalachicola	35	11	.....	30.00	30.04	.....	67.2	+.1	83	27	74	47	8	60	21	62	59	79	6.26	+3.5	7	9.5	s.	27	se.	14	8	11	11	5.6	.0	.0
Pensacola	56	149	185	29.98	30.04	+.02	65.8	−.9	81	28	72	41	8	60	22	60	56	74	2.22	−1.8	6	13.2	s.	34	s.	6	12	13	5	4.5	.0	.0
Anniston	741	9	.....	.....	.....	.....	60.7	+.3	83	26	73	32	8	49	39	.....	.....	...	5.13	+.8	12	.....	w.	.....	.....	.....	12	9	9	.....	.0	.0
Birmingham	700	11	48	29.27	30.02	.00	61.0	−2.3	82	26	72	34	8	50	30	52	45	63	4.47	−.3	9	8.1	s.	26	se.	17	10	11	9	4.9	.0	.0
Mobile	57	86	161	29.97	30.03	+.01	66.2	−.1	83	28	75	40	8	57	28	59	54	71	2.58	−2.0	7	11.0	s.	28	sw.	6	14	13	3	4.1	.0	.0
Montgomery	218	92	105	29.79	30.04	+.01	64.4	−.9	84	15	75	39	8	54	30	55	49	66	2.47	−1.8	9	8.1	s.	21	w.	11	10	11	9	4.9	.0	.0
Meridian	375	67	92	29.62	30.02	.00	62.9	−1.1	83	26	74	34	8	52	36	54	48	66	2.37	−2.4	8	7.2	s.	26	sw.	17	13	7	10	5.0	.0	.0
Vicksburg	247	82	102	29.75	30.01	+.01	63.8	−1.8	83	2	73	38	8	54	32	55	49	66	2.76	−2.4	9	9.9	s.	25	n.	6	10	6	14	5.9	.0	.0
New Orleans	53	76	84	29.97	30.02	+.02	68.4	−.4	85	26	77	42	8	60	26	60	56	70	3.05	−2.2	6	7.9	se.	22	ne.	6	7	14	9	5.2	.0	.0
West Gulf States							**66.0**	**−0.4**										**64**	**2.58**	**−1.1**										**4.8**		
Shreveport	249	92	227	29.74	30.02	+.05	65.0	−.8	87	26	75	39	7	55	36	56	50	63	1.11	−3.5	7	12.9	ne.	39	sw.	16	12	12	6	4.6	.0	.0
Bentonville	1,303	12	38	28.64	30.01	+.05	55.8	−1.1	83	26	66	27	7	45	36	.....	.....	...	4.24	−.1	9	8.6	s.	27	s.	15	12	5	13	.....	.0	.0
Fort Smith	463	57	82	29.52	30.00	+.04	59.7	−2.1	89	26	70	31	7	49	37	51	43	59	4.35	+.4	7	9.4	e.	25	ne.	5	12	10	8	5.1	T	.0
Little Rock	357	94	102	29.62	29.99	+.01	59.6	−2.5	83	26	69	35	7	50	33	51	43	59	7.97	+2.8	8	9.5	s.	39	nw.	26	10	10	10	5.3	.0	.0
Austin	605	68	90	29.32	29.95	.....	69.0	+1.2	99	2	81	37	7	57	41	58	49	57	1.87	−2.5	6	9.2	s.	29	n.	6	13	11	6	4.0	.0	.0
Brownsville	57	88	96	29.86	29.92	.....	73.2	−.5	93	1	81	41	8	65	36	66	62	77	4.09	+2.7	3	12.7	se.	32	s.	15	6	19	5	5.3	.0	.0
Corpus Christi	20	11	78	29.93	29.95	.00	71.9	+1.1	90	16	78	41	8	65	30	65	61	77	1.53	−.2	2	14.2	s.	35	s.	16	10	10	10	5.0	.0	.0
Dallas	512	220	227	29.42	29.96	.....	64.2	.....	86	25	74	37	7	54	34	55	47	60	3.33	−.9	5	14.2	se.	42	n.	6	11	9	10	4.8	.0	.0
Fort Worth	679	92	110	29.26	29.97	+.03	65.0	.0	88	26	76	36	7	54	38	.....	.....	...	1.48	−2.5	4	11.8	n.	43	w.	25	22	3	5	2.8	.0	.0
Galveston	54	106	114	29.93	29.99	+.02	68.6	−.1	84	16	73	44	7	64	19	63	59	76	.68	−2.4	6	12.3	s.	30	s.	14	10	9	11	5.4	.0	.0
Houston	138	137	190	29.84	29.99	.....	68.7	−.6	89	2	78	42	7	59	31	.....	.....	...	1.25	−2.3	4	12.0	se.	29	se.	5	11	9	10	4.8	.0	.0
Palestine	510	64	72	.....	29.99	+.03	65.1	−.9	89	2	75	38	7	55	31	.....	.....	64	1.45	−3.0	4	9.1	s.	36	w.	16	12	7	11	.....	.0	.0
Port Arthur	34	59	134	29.96	30.00	.....	67.7	.....	84	28	75	41	8	60	28	.....	.....	...	1.92	−1.1	6	14.8	s.	41	s.	16	7	14	9	5.7	.0	.0
San Antonio	693	111	301	29.22	29.93	.00	70.8	+1.7	98	2	83	37	7	59	41	58	47	52	.78	−2.4	4	12.2	se.	33	w.	16	10	13	7	4.3	.0	.0

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau Stations, April 1939*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*° F.*	*° F.*	*°F.*		*°F.*	*° F.*		*°F.*	*° F.*	*° F.*	*° F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							52.6	**−2.5**										**64**	**5.44**	**+1.8**										**6.2**		
Chattanooga	762	71	214	29.20	30.01	−0.02	59.8	−.5	85	26	71	35	8	49	36	50	41	55	3.51	−1.3	12	9.1	w.	34	w.	26	10	10	10	5.4	0.0	0.0
Knoxville	995	66	84	28.95	30.01	−.02	57.2	−.8	84	24	68	32	8	47	38	48	41	62	5.00	+.9	11	6.8	sw.	23	w.	18	12	7	11	5.0	.0	.0
Memphis	399	78	86	29.57	30.60	.00	59.2	−2.6	82	24	67	35	7	51	26	51	44	60	7.34	+2.6	10	9.3	s.	32	n.	5	9	11	10	5.5	.0	.0
Nashville	546	168	188	29.44	30.02	+.01	57.0	−2.0	82	26	67	32	7	47	34	49	42	63	3.96	−.2	13	10.5	s.	37	sw.	17	6	12	12	6.2	.0	.0
Lexington	989	6	.....	.....	.....	.....	52.0	−2.3	84	24	63	23	13	41	38	.....	.....	.....	6.46	+3.0	17	.....	w.	.....	.....	.....	11	5	14	.....	.3	.0
Louisville	525	188	234	29.41	29.98	−.03	53.2	−3.2	81	24	62	25	12	45	29	46	39	62	4.96	+1.1	15	11.7	s.	36	s.	17	11	5	14	5.3	T	.0
Evansville	431	76	116	29.52	29.99	−.01	53.8	−2.9	82	24	62	27	12	46	25	47	40	63	6.05	+2.2	16	10.6	sw.	38	sw.	17	8	4	18	6.5	T	.0
Indianapolis	822	98	129	29.08	29.97	−.03	49.6	−2.5	81	24	58	23	12	41	28	43	35	63	5.74	+2.1	16	9.6	w.	27	nw.	1	7	6	17	6.6	T	.0
Terre Haute	575	63	149	29.34	29.96	.....	51.0	.....	82	24	60	25	12	42	28	44	38	67	7.42	+3.8	13	11.1	sw.	37	sw.	17	9	6	15	6.1	T	.0
Cincinnati	627	11	51	29.30	29.98	−.03	50.7	−1.7	82	24	60	27	12	42	31	43	37	65	7.35	+4.2	17	9.4	sw.	32	sw.	10	9	6	15	6.3	.2	.0
Columbus	822	90	210	29.09	29.97	−.05	48.4	−2.8	81	25	57	25	12	39	30	42	36	66	4.62	+1.8	17	11.6	s.	40	sw.	21	7	6	17	7.0	.2	.0
Dayton	909	186	213	29.00	29.96	.....	48.6	−3.0	80	24	57	25	12	40	27	42	36	66	4.68	+1.5	15	12.3	sw.	43	sw.	21	7	8	15	6.4	T	.0
Elkins	1,947	65	83	27.92	29.99	−.04	47.0	−1.8	82	25	58	21	8	36	46	41	34	68	6.53	+2.9	20	8.0	w.	31	nw.	30	4	9	17	7.2	1.7	.0
Parkersburg	637	77	84	29.28	29.97	−.06	50.9	−2.5	85	25	61	27	8	40	40	44	37	66	5.86	+2.7	19	7.8	sw.	28	w.	30	6	12	12	6.0	.1	.0
Pittsburgh [1]	1,273	39	54	28.59	29.96	−.06	47.2	−4.0	80	24	56	23	12	38	36	40	35	69	3.16	+.2	17	12.7	sw.	38	nw.	12	3	12	15	7.3	.4	.0
Lower Lake Region							**43.0**	**−2.4**										**74**	**3.25**	**+0.8**										**7.3**		
Buffalo	768	243	280	29.08	29.93	−.08	39.0	−3.8	71	26	45	23	12	33	28	35	32	79	2.46	−.1	17	16.0	sw.	49	sw.	21	2	6	22	7.8	3.4	.0
Canton	448	10	61	29.42	29.91	.....	38.2	−4.3	62	21	47	21	4	30	28	35	31	79	2.55	+.4	21	9.5	nw.	33	sw.	21	4	9	17	7.5	6.2	.0
Ithaca	836	77	100	29.01	29.93	.....	43.5	−1.5	81	24	52	20	9	35	40	38	34	73	2.51	.0	20	10.3	nw.	33	s.	21	2	7	21	7.8	4.2	.0
Oswego	335	71	85	29.55	29.92	−.09	40.6	−3.0	77	24	48	25	4	34	39	36	32	75	2.66	+.3	19	10.0	w.	25	w.	12	3	7	20	8.0	2.0	.0
Rochester	523	86	102	29.36	29.95	−.06	42.0	−2.9	77	24	49	24	9	35	34	37	33	73	2.59	+.2	18	9.7	w.	29	w.	24	3	5	22	8.2	3.9	.0
Syracuse	596	65	79	29.27	29.92	−.09	43.1	−1.6	78	24	51	25	12	36	36	.....	.....	.....	2.59	+.1	23	7.7	w.	22	w.	12	2	8	20	7.9	5.4	.0
Erie	690	57	81	29.16	29.94	−.08	43.6	−1.5	80	24	50	24	12	38	22	38	34	76	3.22	+1.5	15	9.9	sw.	32	se.	17	4	7	19	7.3	3.3	.0
Cleveland	762	267	318	29.11	29.94	−.08	45.5	−.7	79	24	53	20	12	38	29	39	34	68	2.80	+.4	17	16.5	sw.	47	w.	12	7	8	15	6.6	2.2	.0
Sandusky	629	5	67	29.25	29.94	−.08	45.5	−1.7	82	24	53	24	12	38	35	.....	.....	.....	4.34	+1.8	17	11.1	sw.	30	nw.	12	5	7	18	7.0	.9	.0
Toledo	628	79	87	29.27	29.96	−.05	45.0	−2.6	80	25	53	22	12	37	30	39	33	67	4.77	+2.1	17	11.8	w.	30	sw.	24	8	10	12	6.2	.5	.0
Fort Wayne	857	69	84	29.02	29.96	.....	45.2	−3.2	78	24	53	21	12	37	29	40	35	72	4.49	+1.4	17	10.8	sw.	32	sw.	17	7	11	12	6.2	T	.0
Detroit [1]	626	5	78	29.25	29.94	−.08	44.2	−2.0	81	24	52	20	12	36	29	39	35	73	4.04	+1.6	14	12.4	sw.	31	sw.	24	4	7	19	7.3	.7	.0
Upper Lake Region							**39.4**	**−2.2**										**73**	**2.67**	**+0.2**										**6.6**		
Alpena	609	13	89	29.25	29.93	−.09	36.9	−1.7	73	24	44	12	9	30	35	33	28	74	2.22	.0	10	11.6	nw.	38	nw.	3	7	9	14	6.4	1.9	.0
Escanaba	612	41	49	29.28	29.96	−.06	35.8	−2.1	71	29	44	11	9	28	35	32	28	76	2.04	−.2	10	10.8	n.	35	nw.	12	5	9	16	6.9	3.4	.0
Grand Rapids	707	70	244	29.16	29.94	−.08	44.0	−3.0	82	25	52	19	12	36	29	38	33	70	4.16	+1.4	14	12.6	sw.	40	sw.	17	6	6	18	7.0	4.9	.0
Lansing	878	5	90	28.98	29.93	.....	43.0	−2.6	82	25	52	19	12	34	31	38	35	76	4.21	+1.6	13	10.1	sw.	26	sw.	7	4	12	14	6.7	8.1	.0
Marquette	734	44	69	29.14	29.95	−.07	34.8	−3.0	81	25	42	13	7	27	46	31	28	78	3.04	+.6	11	7.5	nw.	26	nw.	12	8	11	11	6.0	4.7	.0
Sault Sainte Marie [1]	724	5	33	.....	29.94	−.09	34.1	−3.3	66	26	43	4	7	25	.....	.....	.....	81	1.76	.4	14	8.8	nw.	27	nw.	2	6	6	18	.....	5.8	.0
Chicago	673	7	131	29.22	29.96	−.04	45.2	−1.7	81	24	53	21	12	38	28	39	34	71	3.22	+.4	13	10.9	sw.	27	sw.	17	8	10	12	6.2	1	.0
Green Bay	617	109	141	29.25	29.92	−.09	41.1	−2.1	82	25	49	17	12	33	31	36	30	67	1.94	−.7	10	10.9	w.	32	nw.	12	4	9	17	7.4	.2	.0
Milwaukee	681	97	221	29.18	92.93	−.06	43.7	−.1	85	24	52	19	12	36	31	38	31	64	2.81	+.1	11	13.2	w.	31	sw.	17	6	9	15	6.7	.6	.0
Duluth	1,133	5	47	28.72	29.96	−.05	35.1	−1.9	75	29	44	12	8	26	38	30	25	71	1.28	−.8	6	13.3	nw..	36	ne.	17	10	6	14	6.0	8.0	.0
North Dakota							**41.6**	**+0.6**										**62**	**0.86**	**−0.8**										**5.3**		
Moorhead, Minn	940	50	58	28.95	29.98	−.01	40.3	−.3	81	30	51	9	11	30	37	35	29	69	.91	−1.3	10	9.6	n.	26	n.	17	6	10	14	6.4	1.3	.0
Bismarck	1,677	8	57	28.18	29.98	+.01	43.9	+1.8	86	30	56	11	11	31	42	36	27	58	.69	−.8	7	10.6	nw.	34	n.	17	12	10	8	4.7	.3	.9
Devils Lake	1,478	11	44	28.40	30.00	+.01	39.4	+.6	82	30	51	3	11	28	38	33	26	65	1.05	−.5	9	10.5	nw.	33	n.	17	6	11	13	6.3	2.3	.0
Lemmon, S. Dak	2,602	4	38	.....	.....	.....	.....	51	6	11	28	40	34	29	.....	.98	−.6	9	26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.6	.0
Grand Forks	833	12	67	39.6	−2.1	83	30	51	6	11	28	40	34	29	.....	.98	−.6	9	.....	.....	.....	.....	.....	.....	.....	26	nw.	.....	.....	.....	1.6	.0
Williston	1,878	42	50	28.00	30.00	+.04	45.0	+3.0	88	30	57	9	11	33	43	36	26	56	.65	−.6	4	9.4	n.	26	nw.	4	14	11	5	3.9	4	.0
Upper Mississippi Valley							**48.1**	**−2.3**										**65**	**3.50**	**+0.5**										**6.1**		
Minneapolis, St. Paul, Minn. [1]	848	32	61	29.03	29.95	−.04	42.4	−4.0	83	24	52	15	12	33	36	36	29	64	2.19	.0	11	12.6	nw.	40	ne.	16	6	6	18	6.8	4.8	.0
Springfield, Minn	1,025	4	42	.....	.....	.....	44.8	.....	88	24	56	27	11	33	40	37	30	.....	2.10	.....	7	7.6	nw.	.....	.....	.....	.....	.....	.....	.....	2.0	.0
La Crosse	714	11	48	29.16	29.95	−.03	45.1	−2.1	86	24	55	19	12	36	38	38	32	64	2.27	−.2	10	7.0	nw.	19	nw.	26	9	7	14	6.1	T	.0
Madison	974	70	78	28.87	29.94	−.05	42.8	−2.6	82	24	51	17	12	34	30	38	31	68	3.16	+.4	15	10.0	nw.	29	s.	17	7	7	16	6.9	.2	.0
Charles City	1,015	10	51	28.86	29.96	−.02	45.0	−1.4	90	24	56	19	11	34	40	38	32	65	1.28	−1.2	6	8.1	nw.	22	s.	23	11	8	11	5.4	3.4	.0
Davenport	606	66	161	29.29	29.96	−.02	47.8	−2.1	83	24	57	22	12	39	31	41	34	64	2.61	−.1	13	11.7	nw.	41	se.	15	6	11	13	6.4	T	.0
Des Moines	861	5	99	29.04	29.95	−.02	49.5	−.6	86	24	60	22	12	39	40	42	35	63	1.26	−1.6	9	11.9	nw.	30	n.	5	12	9	9	5.1	1.0	.0
Dubuque	699	60	79	29.19	29.95	−.03	46.5	−2.1	85	24	56	21	12	37	36	39	32	62	2.98	+.1	10	7.7	nw.	21	nw.	11	8	7	15	6.2	T	.0
Keokuk	614	64	78	29.30	29.96	−.02	50.4	−1.9	83	24	59	23	12	42	29	44	38	67	4.96	+2.0	14	9.0	nw.	24	sw.	17	8	7	15	6.3	T	.0
Cairo	358	87	93	29.61	29.99	.00	55.8	−2.3	79	24	64	30	12	48	30	49	42	64	4.95	+1.2	14	10.0	s.	35	n.	6	6	8	16	6.3	.0	.0
Peoria	609	11	45	29.30	29.97	−.02	47.7	−3.2	84	24	58	22	12	38	36	42	38	72	5.16	+1.8	13	8.0	w.	21	sw.	17	11	8	11	5.2	T	.0
Springfield, Ill	636	5	191	29.28	29.96	−.02	50.7	−2.0	82	25	60	24	12	41	29	44	38	66	5.37	+1.9	12	12.2	s.	31	n.	5	7	8	15	6.5	.1	.0
St. Louis	568	179	303	29.36	29.97	−.01	53.1	−3.0	84	24	62	26	12	44	28	46	39	62	5.85	+2.0	12	12.3	nw.	30	sw.	10	9	6	15	5.7	T	.0
Missouri Valley							**51.2**	**−0.3**										**60**	**2.72**	**−0.2**										**5.7**		
Columbia, Mo	784	6	66	29.12	29.96	−.02	53.2	−1.7	84	25	63	23	12	44	32	.....	.....	.....	4.52	+.8	11	9.2	s.	26	sw.	17	7	8	15	6.3	T	.0
Kansas City [1]	780	32	45	29.16	29.97	+.01	53.9	−.9	85	23	63	27	12	44	33	46	38	61	7.04	+3.9	12	10.5	sw.	30	n.	5	7	9	14	6.2	.1	.0
St. Joseph	967	11	49	28.92	29.97	.....	53.4	−.1	85	23	63	25	12	44	31	45	38	61	2.71	−.5	12	9.9	nw.	27	nw.	18	9	9	12	5.6	T	.0
Springfield, Mo	1,324	5	78	28.57	29.98	+.01	54.1	−1.9	84	25	64	25	12	44	33	46	40	64	3.65	−.2	10	10.1	se.	27	sw.	17	9	8	13	5.8	T	.0
Topeka	987	65	87	28.91	29.96	.....	54.2	−.5	92	23	65	23	12	43	37	46	38	60	3.72	+.9	11	10.7	s.	29	n.	5	8	12	10	5.5	T	.0
Lincoln	1,189	11	81	28.68	29.95	+.01	51.6	+.1	88	23	62	21	12	41	36	44	36	61	1.66	−.9	6	11.6	s.	36	n.	5	9	8	13	5.9	T	.0
Omaha [1]	982	31	44	28.91	29.96	+.01	51.1	−.1	86	23	62	22	12	41	37	43	35	60	.64	−1.9	8	13.3	nw.	37	nw.	17	11	5	14	5.9	1.4	.0
Valentine	2,598	47	54	27.24	29.97	+.03	46.8	+1.1	88	22	59	14	6	35	44	39	30	58	.83	−1.0	10	10.6	n.	32	nw.	17	7	10	13	6.2	1.1	.0
Sioux City	1,138	64	106	28.73	29.96	+.03	48.8	+1.0	87	23	60	18	11	38	38	41	32	57	1.92	−.8	7	11.3	nw.	33	nw.	17	12	9	9	5.1	.5	.0
Huron	1,307	59	74	28.57	29.96	.00	45.4	+.3	87	23	59	12	12	32	46	38	28	58	.47	−1.8	3	15.4	nw.	45	nw.	17	12	10	8	4.8	T	.0
Northern Slope							**46.3**	**+2.9**										**56**	**0.97**	**−0.5**										**6.2**		
Havre	2,507	11	67	27.37	30.02	+.09	46.8	+3.1	95	29	61	16	11	33	52	38	26	52	.36	−.6	6	9.7	nw.	32	nw.	29	9	9	12	5.7	1.7	.0
Helena	4,124	85	111	25.81	30.03	+.06	46.2	+2.7	82	28	58	12	6	35	39	37	26	47	.56	−.6	6	9.0	sw.	32	n.	5	3	5	22	7.7	.3	.0
Missoula	3,263	80	91	.....	.....	.....	49.0	+3.8	86	28	61	22	6	37	43	.....	.....	.....	.83	−.2	7	7.9	w.	29	e.	11	6	8	16	6.5	T	.0
Kalispell	2,973	48	56	26.97	30.03	+.07	46.6	+3.0	82	28	58	22	6	35	40	39	30	58	.56	−.2	5	6.7	nw.	26	sw.	3	6	7	17	6.5	1.0	.0
Miles City	2,371	48	55	27.49	29.99	+.03	48.6	+3.9	89	29	61	17	11	37	42	39	28	53	.94	−.2	8	8.3	nw.	32	nw.	16	10	8	12	5.7	.6	.0
Rapid City	3,259	50	58	26.59	29.97	+.02	46.5	+2.2	87	30	58	14	11	35	45	39	29	56	.74	−1.3	12	10.4	n.	36	nw.	16	8	9	13	6.0	4.2	.0
Cheyenne [1]	6,144	5	39	23.92	29.96	+.05	42.6	+1.7	76	22	56	2	6	30	40	35	27	60	1.81	−.2	11	14.0	nw.	41	n.	4	7	8	15	6.4	20.4	.0
Lander	5,352	60	68	24.63	29.95	+.01	46.5	+4.1	80	28	61	1	6	32	49	36	25	52	.80	−1.3	9	6.2	w.	30	nw.	15	10	12	8	5.4	6.9	.0
Sheridan	3,790	10	47	26.10	30.02	.....	45.6	.....	85	29	59	12	6	32	51	38	30	63	1.96	.0	9	7.1	nw.	27	nw.	5	9	7	14	5.9	9.3	.0
Yellowstone Park	6,241	12	46	23.89	30.09	+.13	40.8	+4.2	75	29	53	5	6	29	41	33	25	58	.88	−.2	9	8.3	sw.	23	sw.	18	7	8	15	6.0	2.6	.0
North Platte	2,821	11	51	27.03	29.97	+.05	49.2	+.6	91	23	62	16	6	37	49	41	32	59	1.26	−.8	10	9.7	n.	33	nw.	17	9	5	16	5.9	2.4	.0

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau Stations, April 1939*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Maximum velocity: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Middle Slope							54.0	+0.6										55	1.52	−0.8										5.2		
Denver	5,292	106	113	24.70	29.95	+0.05	49.4	+2.3	82	22	62	11	6	37	40	39	28	50	.80	−1.3	10	8.6	s.	35	n.	4	6	10	14	6.1	3.2	0.0
Pueblo	4,690	79	86	25.27	29.95	+.07	51.6	+1.5	85	22	66	16	6	38	45	41	30	54	2.04	+.7	5	7.7	nw.	31	nw.	8	10	11	9	5.4	7.7	.0
Chadron, Nebr.	3,439	4	58																												
Concordia	1,392	50	58	28.49	29.97	+.04	52.8	−.7	92	23	64	24	11	42	36	45	37	61	2.57	+.2	10	10.0	nw.	29	nw.	17	11	9	10	5.4	.4	.0
Dodge City	2,509	10	86	27.35	29.94	+.04	55.0	+1.4	93	23	68	25	6	42	48	45	36	56	.46	−1.5	6	14.2	n.	39	n.	9	12	10	8	4.7	T	.0
Wichita	1,358	85	93	28.53	29.96	+.03	55.1	−1.3	84	23	66	28	7	45	30	46	38	55	2.14	−.8	9	11.6	n.	28	sw.	24	11	10	9	5.1	T	.0
Oklahoma City	1,214	10	47	28.67	29.95	+.03	60.2	+.4	91	25	72	29	7	49	33	49	41	56	1.08	−2.2	3	11.0	s.	27	n.	5	12	10	8	4.7	T	.0
Southern Slope							64.8	+2.0										44	0.87	−0.9										4.2		
Abilene	1,738	10	52	28.13	29.92	+.02	67.9	+3.5	97	9	82	32	7	54	45	52	37	42	.09	−2.6	5	12.1	s.	30	n.	5	16	6	8	4.1	T	.0
Amarillo	3,676	10	49	26.23	29.94	+.07	58.2	+2.4	88	22	71	24	6	45	40	45	33	49	2.30	+.5	5	10.8	se.	35	ne.	5	14	7	9	4.9	3.3	.0
Del Rio	960	63	71	28.91	29.88	−.01	72.2	+1.6	98	3	84	33	7	60	42	57	44	44	.52	−1.3	5	10.4	se.	38	nw.	16	10	13	7	4.7	T	.0
Roswell	3,566	75	85	26.33	29.90	+.05	61.0	+.4	88	9	76	24	7	46	46	47	31	40	.57	−.3	2	9.7	s.	39	ne.	10	18	10	2	3.0	.2	.0
Southern Plateau							60.3	+3.5										40	0.54	0.0										3.1		
El Paso	3,778	82	101	26.15	29.88	+.05	65.6	+2.2	90	22	79	26	7	52	40	48	29	30	.45	+.2	2	9.9	w.	33	ne.	6	22	5	3	2.4	T	.0
Albuquerque [1]	5,314	5	39	25.02	29.88		56.0	+2.0	84	22	72	27	7	40	44	42	27	40	.86	+.3	4	10.2	s.	39	e.	6	16	10	4	3.5	.2	.0
Santa Fe	7,013	38	53	23.22	29.92	+.08	49.2	+2.5	73	22	61	20	6	37	35	37	23	41	1.19	+.2	6	7.2	e.	27	w.	9	9	15	6	4.8	4.3	.0
Flagstaff	6,907	10	59	23.35	29.88	+.04	46.2	+4.0	74	8	62	13	15	30	45	38		61	.57	−.7	7	10.0	nw.	40	n.	6	11	15	4		1.0	.0
Phoenix	1,107	39	51	28.73	29.87	.00	71.2	+4.2	99	22	87	44	15	56	43	52	33	30	.17	−.2	2	6.5	e.	27	se.	28	16	10	4	3.5	.0	.0
Yuma	141	9	54	29.73	29.87	−.02	73.8	+4.3	102	21	91	46	15	57	45	56	39	37	T	−.1	0	6.1	w.	34	w.	13	27	3	0	1.2	.0	.0
Independence	3,957	5	26				60.1	+5.0	84	8	75	32	13	46	41	46	28		.57	+.4	3		w.									.0
Middle Plateau							53.3	+5.1										43	0.21	−0.6										4.3		
Reno	4,527	61	76	25.49	30.00	+.03	54.8	+7.3	80	7	69	32	13	40	42	43	30	43	.11	−.4	1	7.5	w.	23	w.	24	17	11	2	3.0	1.0	.0
Tonopah	6,090	12	20				52.6		74	8	62	25	14	43	27	41	29	46	1.09		6		nw.								8.0	.0
Winnemucca	4,344	18	56	25.63	30.01	+.04	52.5	+5.8	81	27	70	25	15	35	48	40	24	39	.18	−.7	6	8.0	ne.	2o	ne.	13	7	14	9	5.4	T	.0
Modena	5,473	10	43	24.60	29.92	+.04	50.2	+4.2	77	28	66	22	14	34	50	39	24	44	.49	−.4	5	10.5	sw.	34	s.	13	16	5	9	4.5	3.3	.0
Salt Lake City [1]	4,227	32	46	25.73	29.97	+.05	52.6		83	28	65	27	6	40	38	42	31	48	.92		7	9.6	nw.	42	nw.	5	12	12	6	4.4	.0	.0
Grand Junction	4,602	60	68	25.35	29.91	+.03	55.6	+3.2	85	28	69	28	6	42	38	42	26	37	.05	−.8	2	7.1	se.	29	s.	23	12	11	7	4.3	.0	.0
Northern Plateau							52.9	+3.0										47	0.42	−0.6										5.6		
Baker	3,471	48	53	26.50	30.08	+.08	48.4	+3.2	84	28	63	21	6	34	43	40	29	51	.29	−.8	1	7.3	n.	24	s.	21	7	10	13	6.1	2.2	.0
Boise	2,739	79	87	27.20	30.06	+.08	53.6	+3.2	88	28	67	26	13	40	40	42	29	44	.36	−.8	3	6.5	se.	25	se.	28	8	13	9	5.3	T	.0
Pocatello [1]	4,466	5	31	25.48	30.00	+.06	48.8		83	28	63	14	6	35	46	39	27	49	.44		7	11.4	sw.	38	w.	30	10	9	11	5.0	1.3	.0
Spokane	1,929	101	110	28.01	30.07	+.08	51.6	+3.2	87	28	64	28	6	40	35	42	32	52	.61	−.5	2	7.2	s.	21	s.	29	9	11	10	5.5	T	.0
Walla Walla	991	57	65	29.00	30.06	+.05	55.6	+2.5	87	28	67	33	6	44	34	45	32	44	.60	−.9	3	6.2	s.	26	w.	8	9	10	11	5.7	.0	.0
Yakima	1,076	58	67	28.92	30.08		55.2	+2.7	85	28	69	29	4	42	37	44	29	41	.25	−.2	1	6.7	nw.	25	sw.	8	7	13	10	5.8	.0	.0
North Pacific Coast Region							53.1	+3.6										64	0.89	−2.2										6.6		
North Head	211	11	56	29.92	30.15	+.10	50.0	+2.5	74	16	55	39	4	45	28	46	42	78	1.14	−3.0	10	13.4	n.	40	s.	24	5	5	20	7.4	.0	.0
Seattle	125	90	321	29.99	30.12	+.09	53.6	+4.2	78	17	62	40	30	45	36	46	38	51	.16	−2.2	5	8.9	s.	30	s.	8	7	9	14	6.6	.0	.0
Tacoma	194	172	201	29.92	30.13	+.10	52.3	+3.6	79	17	61	36	4	44	32				.37	−2.4	9	8.3	n.	31	sw.	8	5	14	11	6.2	.0	.0
Tatoosh Island	86	9	55	30.03	30.13	+.13	47.6	+1.5	66	16	52	38	4	44	21	44	41	78	3.54	−2.1	16	13.3	sw.	39	s.	25	5	9	16	6.6	.0	.0
Medford	1,329	29	58	28.68	30.09		56.6	+4.5	90	19	73	33	14	40	47	46	37	57	.29	−1.0	5		nw.				7	9	14	6.2	T	.0
Portland, Oreg	154	68	106	29.97	30.13	+.07	56.0	+4.2	84	20	66	38	5	46	36	48	40	59	.55	−2.3	9	6.0	nw.	22	sw.	28	6	8	16	6.8	.0	.0
Roseburg	510	45	76	29.57	30.12	+.05	55.4	+4.4	89	20	70	33	30	41	46	48	39	61	.15	−2.1	6	4.3	n.	18	sw.	28	6	9	15	6.5	.0	.0
Middle Pacific Coast Region							59.2	+3.5										63	0.29	−2.0										4.8		
Eureka	60	72	88	30.08	30.15	+.04	51.2	+1.3	70	28	56	38	13	46	23	48	45	84	.37	−3.0	6	7.8	n.	32	n.	13	7	9	14	6.7	.0	.0
Redding [1]	722	20	34				65.4	+5.6	92	19	78	44	13	53	35	51	35	36	.11	−2.5	2	8.4	nw.	29	nw.	12	9	13	8	5.0	.0	.0
Sacramento	66	92	115	29.93	30.00	−.01	64.3	+6.2	91	18	79	44	13	50	39	53	43	53	.25	−1.3	3	7.5	s.	21	nw.	5	20	10	0	2.3	.0	.0
San Francisco	155	112	132	29.88	30.05	.00	55.8	+.8	83	6	62	45	13	49	27	50	46	78	.42	−1.2	3	10.4	w.	29	w.	11	10	12	8	5.0	.0	.0
South Pacific Coast Region							63.5	+4.1										65	0.36	−0.6										4.5		
Fresno	327	97	105	29.64	30.00	+.01	66.4	+6.2	93	20	80	42	14	53	36	54	44	50	.37	−.6	3	6.6	nw.	18	nw.	13	19	8	3	3.0	.0	.0
Los Angeles	338	159	191	29.63	30.00	+.01	63.0	+3.6	91	6	72	48	14	54	37	54	49	68	.24	−.8	2	5.7	sw.	24	sw.	13	11	14	5	4.5	.0	.0
San Diego	87	62	70	29.90	30.00	+.01	61.0	+2.5	89	6	68	48	15	54	34	55	51	76	.47	−.3	6	6.8	w.	21	w.	14	6	13	11	6.0	.0	.0
West Indies																															
San Juan, P. R.	82	9	54	29.96	30.06		75.6	−1.0	88	30	80	67	13	71	14				4.09	−.3	18	14.0	e.	27	e.	23	8	21	1	4.5	.0	.0
Panama Canal																															
Balboa Heights	118	6	92		[2] 29.83	+.01	82.2	+.6	95	25	91	69	1	74	21			[2] 73	.94	−1.9	3	9.2	nw.	25	n.	22	10	18	2	4.5	.0	.0
Cristobal	36	6	97		[2] 29.88	+.02	82.0	+.2	87	15	86	75	2	78	10	75	72	[2] 75	1.00	−3.1	11	13.5	n.	24	n.	19	10	16	4	4.5	.0	.0
Alaska																															
Fairbanks	454	11	87		[2] 29.87		32.0	+3.3	54	11	44	−25	1	20	46			58	T	−.3	0	6.5	ne.	21	ne.	25	7	9	14		T	.0
Juneau	80	96	116	[2] 29.89	[2] 29.98		38.2	−2.2	52	11	43	20	3	33	18	35	29	71	4.80	−.5	24	8.2	s.	32	n.	2	1	3	26	8.8	1.2	.0
Nome	22	5	32	[2] 29.69	[2] 29.71		24.1	+6.9	39	12	30	−1	27	19	21	25	23	87	1.77	+1.2	18	14.1	e.	43	n.	24	4	3	23	8.5	15.8	29.4
Hawaiian Islands																															
Honolulu	38	86	100	30.00	30.04		72.3	−.7	80	27	76	65	5	68	11	67	64	76	6.29	+4.2	16	9.9	e.	28	e.	18	5	13	12	6.1	.0	.0

[1] Observations taken at airport.
[2] Observations taken hourly.
[3] Pressure not reduced to a mean of 24 hours.

TABLE 3.—*Data furnished by the Canadian Meteorological Service, April 1939*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+ mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99												
Sydney, Cape Breton Island	48	29.75	29.88	−0.04	36.2	+0.7	43.9	28.6	63	19	3.29	−0.58	11.1
Halifax, Nova Scotia	88	29.64	29.91	−.02	37.4	−2.0	43.0	31.8	60	24	5.95	+1.40	18.2
Yarmouth, Nova Scotia	65	29.80	29.91	−.04	38.6	−1.3	44.9	32.3	56	24	6.13	+2.44	11.4
Charlottetown, Prince Edward Island	38	29.82	29.91	−.01	35.0	−1.6	41.6	28.4	60	16	4.45	+1.76	23.1
Chatham, New Brunswick	28	29.76	29.87	−.07	34.4	−2.7	43.5	25.4	57	11	2.94	−.07	14.5
Father Point, Quebec	20	29.89	29.91	−.03	33.7	+.1	39.3	28.0	49	16	1.69	−.28	6.3
Quebec, Quebec	296												
Doucet, Quebec	1,236	28.56	29.93	−.06	29.4	+1.2	39.7	19.2	57	−8	1.30	−.46	11.4
Montreal, Quebec	187												
Ottawa, Ontario	236	29.54	29.91	−.07	35.0	−6.5	41.4	28.5	62	12	2.17	−.11	10.4
Kingston, Ontario	285	29.60	29.92	−.07	38.2	−3.0	46.2	30.1	62	21	2.28	−.05	7.1
Toronto, Ontario	379	29.51	29.93	−.08	40.6	−2.2	46.7	34.4	76	24	3.43	+.97	7.7
Cochrane, Ontario	930	28.89	29.94	−.10	28.6	−3.6	37.3	19.9	52	−3	2.81	+1.24	17.0
White River, Ontario	1,244	29.58	29.97	−.05	26.6	−5.4	40.6	12.6	60	−20	2.68	+1.14	23.5
London, Ontario	808	29.04	29.94		40.7	−3.1	48.2	33.2	79	14	4.09	+1.27	3.4
Southampton, Ontario	656	29.19	29.91	−.08	37.0	−3.0	43.5	30.6	71	20	2.87	+.58	14.2
Parry Sound, Ontario	688	29.21	29.92	−.07	36.8	−2.4	44.8	28.9	71	18	2.65	+.37	9.4
Port Arthur, Ontario	644	29.24	29.97	−.06	31.7	−3.8	41.6	21.8	76	2	.76	−.68	6.2
Winnipeg, Manitoba	760	29.14	30.01	−.07	37.0	−1.0	48.3	25.6	83	3	1.08	−.26	.6
Minnedosa, Manitoba	1,690	28.17	30.03	+.02	37.2	−.4	50.0	24.3	84	3	.42	−.74	1.6
Le Pas, Manitoba	860	29.04	30.04	+.01	31.4	−1.6	46.0	16.7	85	−14	.77	+.07	5.3
Qu'Appelle, Saskatchewan	2,115	27.71	30.02	+.02	39.4	+2.0	52.1	26.7	87	5	.65	−.50	2.7
Moose Jaw, Saskatchewan	1,759	28.00	30.02	+.06	42.4	+3.1	55.4	29.3	91	11	.32	−.44	2.4
Swift Current, Saskatchewan	2,392	27.15	30.00	+.03	42.1	+.8	54.7	29.5	92	9	.66	−.16	3.8
Medicine Hat, Alberta	2,365	27.50	30.01	+.07	44.9	−.1	57.6	32.2	92	15	.90	+.15	5.9
Calgary, Alberta	3,540	26.33	30.03	+.08	41.6	+1.7	53.9	29.2	83	8	1.09	+.14	7.5
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450	28.46	30.04	+.04	36.9	+.3	48.4	25.4	89	0	.99	+.07	7.7
Battleford, Saskatchewan	1,592	28.24	30.00	+.02	40.2	+2.0	51.6	28.8	94	8	.28	−.34	2.0
Edmonton Alberta	2,150	27.70	30.02		42.2	+2.6	54.0	30.3	90	3	.91	.00	3.9
Kamloops, British Columbia	1,262	28.69	30.05	+.09	52.2	+2.6	64.7	39.6	87	25	.24	−.17	.0
Victoria, British Columbia	230	29.87	30.12	+.09	50.1	+1.7	57.4	42.8	71	36	.36	−1.08	.0
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20	30.09	30.12	+.11	46.5	+1.2	51.9	41.1	58	35	7.34	+.43	.0
Prince Rupert, British Columbia	170												
Hamilton, Bermuda	158		30.14	+.09	67.6	+2.8	72.9	62.2	79	55	1.88	−2.53	.0
LATE REPORTS FOR MARCH 1939													
Cape Race, Newfoundland	99				22.9	−4.8	29.1	16.8	38	−4	5.10	+1.20	27.1
Quebec, Quebec	296	29.71	30.05	+0.09	19.4	−2.9	27.2	11.7	41	−13	2.22	−.98	21.4
Banff, Alberta	4,521				27.8	+3.4	40.6	14.9	62	−22	.26	−.92	2.1
Kamloops, British Columbia	1,262	28.69	30.06	+.13	38.0	+.1	47.4	28.5	67	3	.24	−.12	2.1
Estevan Point, British Columbia	20	30.03	30.06	+.04	42.8	.0	47.6	38.1	55	28	8.98	−.23	.0
Prince Rupert, British Columbia	170	29.78	29.98	+.12	38.4	−.6	43.1	33.8	50	25	7.45	−1.67	1.6

TABLE 4.—*Severe local storms, April 1939*

[Compiled by Mary O. Souder from reports submitted by Weather Bureau officials]

[The table herewith contains such data as has been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Gainesville and Newberry, Fla., and vicinities.	1	1:30 p. m.	[1] 2		$500	Hail	Loss to crops.
Jalapa, S. C., vicinity of	1	4 p. m.	75	0	150	Tornado	Tenant house, barn, and stable damaged; in some places trees were blown down; path 7 miles long.
Neeses, S. C	1	do			1,000	Electrical	Cotton warehouses destroyed.
Fairfield County, S. C	1	5 p. m.		0	4,000	Tornado	Residence and several outbuildings unroofed.
Norfolk, Va	1	7:28–7:40 p. m.			7,000	Thundersqualls	Number of store windows blown in; trees uprooted.
Dermott, Ark	1				50,000	Heavy rain	Cloudburst washed out dam at Lake Wallace; millions of game fish lost.
Mountain Home, Ark	1				500	Wind	Property damaged.
Kerman and Biola,[2] Calif., and vicinities.	1					Wind and hail	Trees and poles blown down; 12,000 acres of young grapevines destroyed by hail.
Dallas, Tex	5	1:26 p. m.	[1] 7		25,000	Heavy hail	Principal damage to property; same loss to fruit and crops.
Marietta, Ohio, and vicinity	5	7 p. m.				do	Greenhouses and cars damaged.
Stephens, Ark	5	8 p. m.	200	3	15,000	Tornado	3 persons injured; property damaged; path 880 yards long.
Shaw, La	5	Midnight	117	0	10,000	do	Property destroyed; 12 persons injured, 2 seriously, path 2 miles long.
Amarillo, Tex.[3]	5				100,000	Rain, wind, electrical.	Fire in ice plant because of lightning; radio tower damaged by wind; rain turned to snow in the evening.
Denver, Colo	5–6	6:20 p. m.; 5th–4:40 a. m., 6th.				Snow	3 inches of snow recorded. Several highways leading to Denver closed; visibility poor. In some sections, streets and highways were coated with ice.
Stringer, Miss., 3 miles southeast.	6	2 a. m.	50	0	6,000	Tornado	Storm moved from southwest to northeast; property damaged; path 1½ miles long.
San Antonio, Tex	6	7:28 p. m.			60,000	Hail	Property damaged.
Do	7	1:53 a. m.			60,000	Wind	Do.
Finney, Hodgeman, Pawnee, and Stafford Counties, Kans.	9	9–11 p. m.	[1] 20		100,000	do	Roofs, buildings, windmills, elevators, and wires damaged; path 75 miles long.
Florence, Kans., 6 miles west	10	1:15 a. m.	[1] 2		25,000	do	Small buildings blown down; roofs torn off; wires damaged; path 8 miles long.
Kensett, Ark	10	P. m.			1,000	Thunderstorm	Barn burned; mule killed.
Reno, McPherson, and Harvey Counties, Kans.	10–11	Midnight–12:30 a. m.	[1] 15		40,000	Wind	Property damaged; path 40 miles long.
Morgan County, Ala., northwestern portion.	11	9 a. m.			3,000	do	Property damaged; 1 person injured.
Jackson County, Ala., southeastern portion.	11	10 a. m.			5,000	do	Property damaged.
Madison County, Ala., southeastern portion.	11	10:25 a. m.	100	1	500	do	Property damaged; 1 person injured.
Montevallo, Ala	11	11:45 a. m.	100	0	30,000	Tornado	Property damaged; 4 persons injured.
Lucas, Fulton, and Williams Counties, Ohio.	12					Wind and sleet	Considerable damage to utility lines and trees.
Buffalo, Okla	14	8 p. m.	[1] 2–4		10,000	Heavy hail	Much damage to buildings; small loss to crops, trees, and gardens; path 25 miles long.
Ness City, McCracken, and La Crosse, Kans.	14	8:30–11 p. m.	[1] 15		12,500	do	Property damaged; path 40 miles long.
Coldwater, Kans., and vicinity.	14	9 p. m.	440	0	10,000	Tornado	Damage to farm buildings.
Vici to Waynoka, Hopeton, and Capron, Okla., and vicinities.	14–15	11 p. m. 14th; 12:15 a. m., 15th.		7	104,125	Tornado, rain and hail.	Storm originated in Vici, moved in a northeasterly direction, reaching Capron at 12:15 a. m., on the 15th; dissipating soon after in Kansas just north of the Oklahoma-Kansas boundary. Many farmhouses and buildings in the vicinity of Waynoka, Hopeton, and Alva, as well as the entire business section and a brick school house at Capron destroyed. 19 persons injured. 8 freight cars completely demolished as a freight train arrived in Capron simultaneously with the tornado.
Marshall, Mo., 3 miles southwest.	15	2:30 a. m.	300	0	27,000	Tornado	Storm traveled from southwest to northeast. 6 persons injured; buildings demolished.
Springfield, Ill	15	2:43–5:29 a. m.			685	Electrical	3 residences and a shop damaged.
Phillipsburg, Kans, 2 miles west.	15	2:15 p. m.	100	0	200	Tornado	Vortex cloud observed, but reached the ground only for an interval; path 440 yards long.
Nowata, Okla	15	2:30–2:55 p. m.	[1] 6		35,400	Hail	Property damage, $35,000; loss in corn crop, $400; path 12 miles long.
Carthage, Carterville, Joplin, and Wells City, Mo., and vicinities.	15	4 p. m.			268,000	Hail, rain, and wind.	In some places, hail piled up to a depth of from 12 to 14 inches. Much damage to windows, roofs, automobile tops, greenhouses, neon electric signs, crops, and fruit trees. In Carthage 2 persons were injured by flying glass; damage, mostly from hail, estimated at between $250,000 and $300,000. 50 percent loss to early barley and rye; gardens ruined. Property damage in Carterville estimated at from $18,000 to $20,000 with small crop loss. Path 880 yards to 4 miles wide.
Pitcher, Okla	15	do	[1] 1		21,000	Hail	Property damage, $20,000; loss to crops, $1,000; path 6 miles long.
Millsap, Tex	15	4:30 p. m.	67	0		Tornado	2 persons injured; several outbuildings blown down; roofs damaged.
Weatherford, Tex., and vicinity.	15	5:30 p. m.	100	0	3,000	do	Residence demolished; barn, windmill, and residence damaged.
Pine Bluff, Ark	15	6 p. m.			30,000	Heavy hail	Roofs, automobile tops, windows, and shrubs damaged.
Azle, Tex	15	do	[1] 1	0	2,000	Tornado	Damage to windows and roofs, $1,000; loss to crops, $2,000.
Auburn, Nebr., and vicinity	15	6:55–7:05 p. m.	[1] 5		10,000	Hail	Property damaged.
Parker County, Tex., western portion.	15	7–7:10 p. m.	[1] 3		60,000	Heavy hail	Property damage, $10,000; loss to crops, $50,000.
Mena, Ark., 3 miles west	15	9:30 p. m.			500	Wind	Property damaged.
Boerne, Tex	15	10:30 p. m.	[1] 6		5,000	Heavy hail	Roofs and windows damaged; small crop loss.
Pipe Creek, Tex	15	10:30 p. m.	150	4	30,000	Tornado	5 persons seriously injured; 3 homes demolished, 6 others damaged; a car overturned and carried 500 yards with parts of the machinery scattered along the way. A piece of lumber pierced a metal water tank, another piece passed through a vane of a windmill. After the storm a dog was found in the top of a tree 200 feet from a residence; small crop loss.
Azle and Eagle Mountain Lake area, Tex.	15	P. m.	[1] 5		40,000	Heavy hail	Property damaged; loss to crops. More than 1,000 migrating pelicans killed by hail over Eagle Mountain Lake.
Gower, Mo	15				10,000	Electrical	Garage burned.
Springfield, Mo., northern portion.	15					Hail	Considerable damage to greenhouses.
Earl, Ark	16	2 a. m.	100	0	25,000	Tornado	Property damaged; path 880 yards long.
Marble Falls, Tex	16	2 a. m.	25	0		do	A factory, several farmhouses, and outbuildings damaged; amount not estimated.
Smithfield, Tex	16	2:30 a. m.	25	0	300	do	Property damaged.
Belfalls, Tex	16	4 a. m.		0	7,500	do	Dairy farm struck; some livestock killed.
Richland, Tex	16	5:30 a. m.	333	0	50,000	do	4 persons injured; about 40 buildings destroyed or damaged; small crop loss.
Athens, Tex	16	6:05 a. m.	100	1		do	2 persons injured; house demolished; 5 barns blown over; 2 houses damaged; no crop loss.

See footnotes at end of table.

TABLE 4.—*Severe local storms, April 1939*—Continued

[The table herewith contains such data as has been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Paris, Ark	16	10:30 a. m			$35,000	Heavy rain	125 feet of an 800-foot dam washed out; house destroyed; considerable damage to farm lands.
Texarkana, Tex	16	11:30 a. m	300	1	50,000	Tornado	48 persons injured; small crop loss. Amount given estimate of property damage only.
Ozan, Ark., 2 miles southwest	16	12:30 p. m	200	0	25,000	do	1 person injured; property damaged; path 5 miles long.
Crane City, Ark	16	1:30 p. m	200	0	15,000	do	3 persons injured; damage to several houses and oil derricks.
Lewisville, Ark	16	do	440	0	1,000	do	Property damaged; path 5 miles long.
Bradley, Ark., vicinity of	16	2 p. m		0	1,500	do	2 persons injured; property damaged; path narrow and short.
Haynesville, La	16	2:10 p. m	200	8	75,000	do	37 homes destroyed, 15 damaged; 200 persons homeless. The body of 1 person and a piano were blown 150 feet. Path from southwest to northeast and 1½ miles long.
Center Point to Tillar, Ark	16	3:10 p. m	440	27	20,000	do	62 persons injured; property damaged. Storm dipped 3 times over the path 15 miles in length; greatest damage in the vicinity of Center Point.
Ingalls, Ark	16	3:30 p. m	150	0	5,000	do	Property damaged; path 3 miles long.
Wabbaseka, Ark., 3 miles east.	16	do	200	2	3,000	do	21 persons injured; property damaged; path a mile long.
Fort Necessity, La	16	3:40 p. m	440	3	5,000	Wind	Several houses destroyed and much timber blown down; path 3 miles long.
Calmer, Ark	16	4:30 p. m	440	1	5,900	Tornado	7 persons injured; property damaged; livestock killed; path 10 miles long. Crop loss, $800; property damage, $5,100.
Bonita, La	16	5:15 p. m	440	0	6,000	do	5 houses destroyed and 6 damaged; 20 persons injured, 5 seriously. Path southwest to northeast and 880 yards long.
Batesville, Miss., 6 miles east	16	6 p. m	[1] 75	0	5,000	do	3 persons injured; property damaged; path 10 miles long.
Webster County, Miss	16	8 p. m			200,000	Wind	4 persons injured, property damaged.
St. Bernard, La	16	10:30 p. m	50	0	1,000	Tornado	Property damaged.
Marked Tree, Ark	16	P. m			500	Wind	Do.
Arkansas	16				250,000	Heavy rain	11 highways closed by high water after rainfall of near cloudburst proportions and 6 major streams were rising rapidly. Damage to roads estimated at $250,000.
Urania, La., southeast of	16			0		Tornado	A house and 2,000,000 feet of lumber destroyed. Storm moved from southwest to northeast.
Marathon and Shawano Counties, Wis., northeastward into upper Michigan.	16–17				20,000	Sleet and glaze	More than 1,000 electric poles broken or cracked. Many trees and branches broken causing some obstruction to traffic. Cities and villages isolated from wire communication over 30 hours. Damage to utilities alone, $20,000.
Green County, Ala., southern portion.	17	1:15 a. m	150	1	10,000	Tornado	Property damaged; 2 persons injured.
Tuscaloosa, Ala., 5 miles north.	17	2 a. m		0	6,000	do	Do.
Cleburne County, Ala., southeastern portion.	17	6:15 a. m	150	0	20,000	do	Property damaged; 16 persons injured.
Wichita, Kans., eastern portion.	17	10:40 a. m		0		do	Storm moved rapidly from northwest to southeast, but did not reach the ground.
Baird, Tex., vicinity of	17	4 p. m	[1] 3–6			Hail	Property damaged; path 12 miles long.
Iowa,[2] northwestern portion	17	P. m				Snow	A 7-inch fall reported at Mason City; roads blocked.
Menno, S. Dak., vicinity of	17	do			1,000	Wind	Windows broken; windmills damaged; path narrow.
Minneapolis, Minn	17					Snow	3.5 inches of snow recorded. High winds during the latter half of the day resulted in some drifting. Traffic delayed.
Ballentine, S. C., vicinity of	17			0	200	Tornado	Cottage unroofed.
Michigan, Upper Peninsula	17–18				15,000	Glaze	This reported to be the worst storm in 30 years. Light, power, telephone, and telegraph service interrupted with many poles and wires down; much damage to trees.
Minnesota, south-central counties.	17–18				5,000	Sleet, snow, and wind.	Greatest damage in vicinity of Glencoe, Belle Plaine, and St. Peter. Wires and poles down; communication and electric service disrupted; traffic seriously delayed by drifts.
Camden, N. J	19	2:24 p. m		0		Tornado and heavy rain.	Property damage light; several signs destroyed. Heavy steel hangar doors blown off their slides. An airplane, with a man inside, picked off the ground and carried about 40 feet, landed right side up without damage. Airplane schedules delayed although no other stations in this vicinity reported wind of any consequence.
Pine Bluff, Ark	20	6:15 p. m			2,000	Hail and wind	2 houses unroofed; hail damaged windows, signs, and street lights.
Fort Worth, Tex	23	2 p. m	[1] 1–4		55,000	do	Property damage, $5,000; loss to crops, $50,000; path 6 miles long.
Shullsburg and Stoughton, Wis., and vicinity.	25–26	P. m			21,000	Thunderstorm	Several farm buildings burned with damage including livestock and hay; $1,000 damage to wires.
Red Moon, Okla., and vicinity.	26	4 p. m	[1] 3		500	Hail	Loss in wheat and barley; path 5 miles long.
Lynn and Dawson Counties, Tex.	26	6 p. m	[1] 1–2	3	30,000	Tornado	More than 50 persons injured; property damaged; path 30 miles long.
Pine Bluff, Ark	26	8:20 p. m	880		5,000	Heavy hail	Property damaged.
Prescott, Ark	26	P. m			500	Wind	Do.
Gonzales, Tex	28			0		Tornado	Property damage amounted to several thousand dollars.
Brownfield, Tex	29	5 p. m	[1] 3			Heavy hail	Loss in fruit crop.
Candor, N. C., vicinity of	29					do	Much loss to fruit crop.

[1] Miles instead of yards.
[2] From press reports.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, and Wind Roses for Selected Stations, April 1939

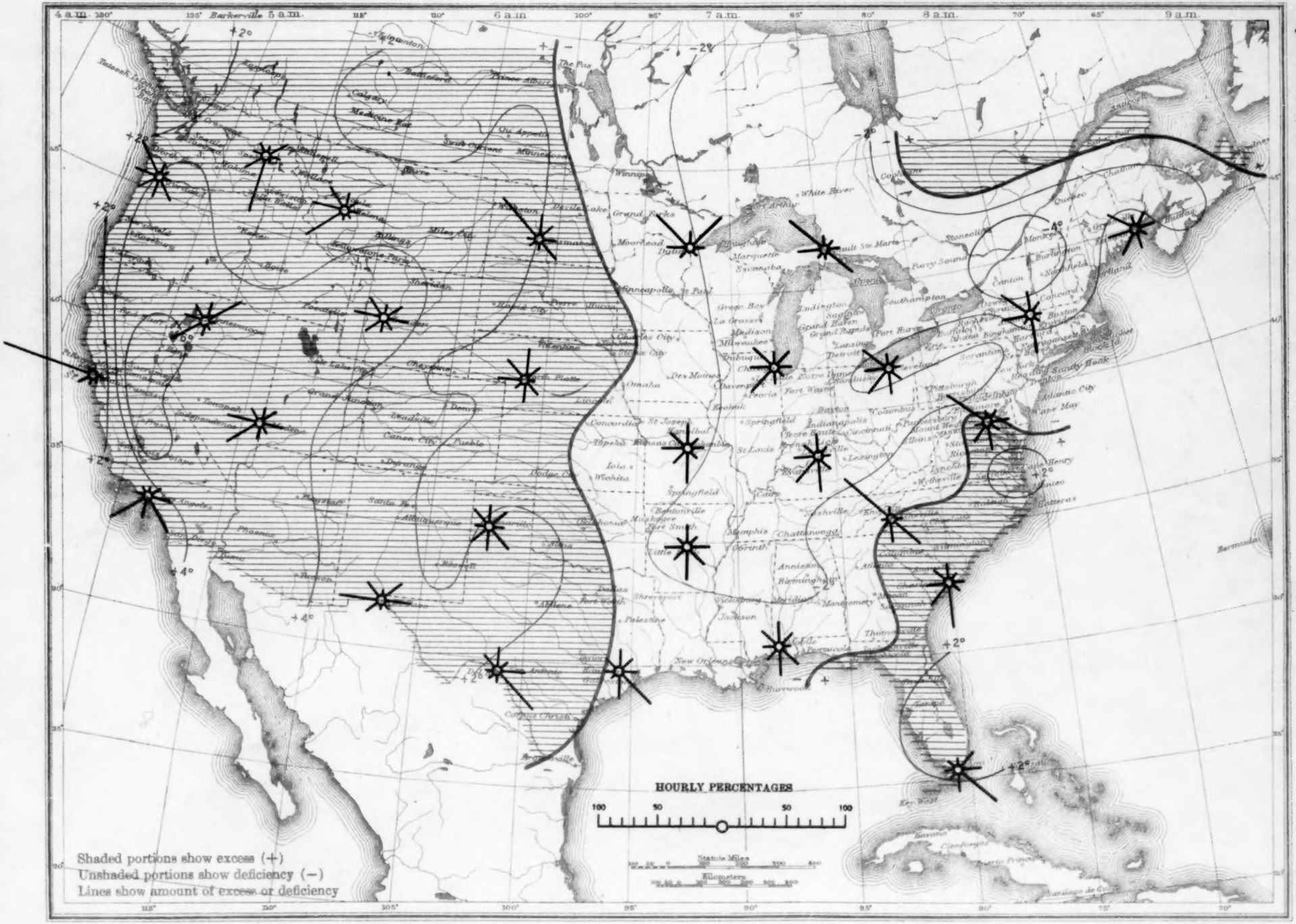
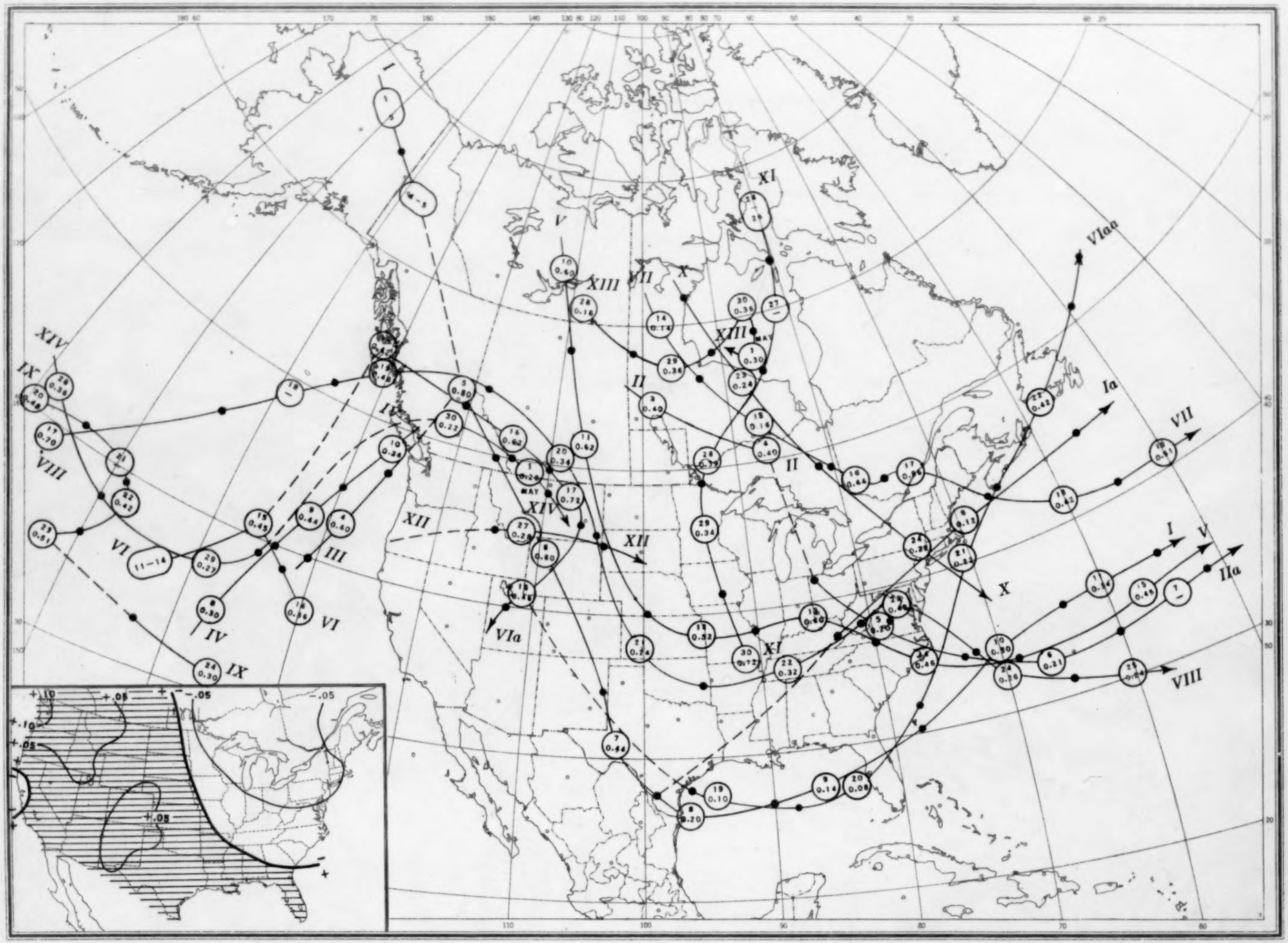


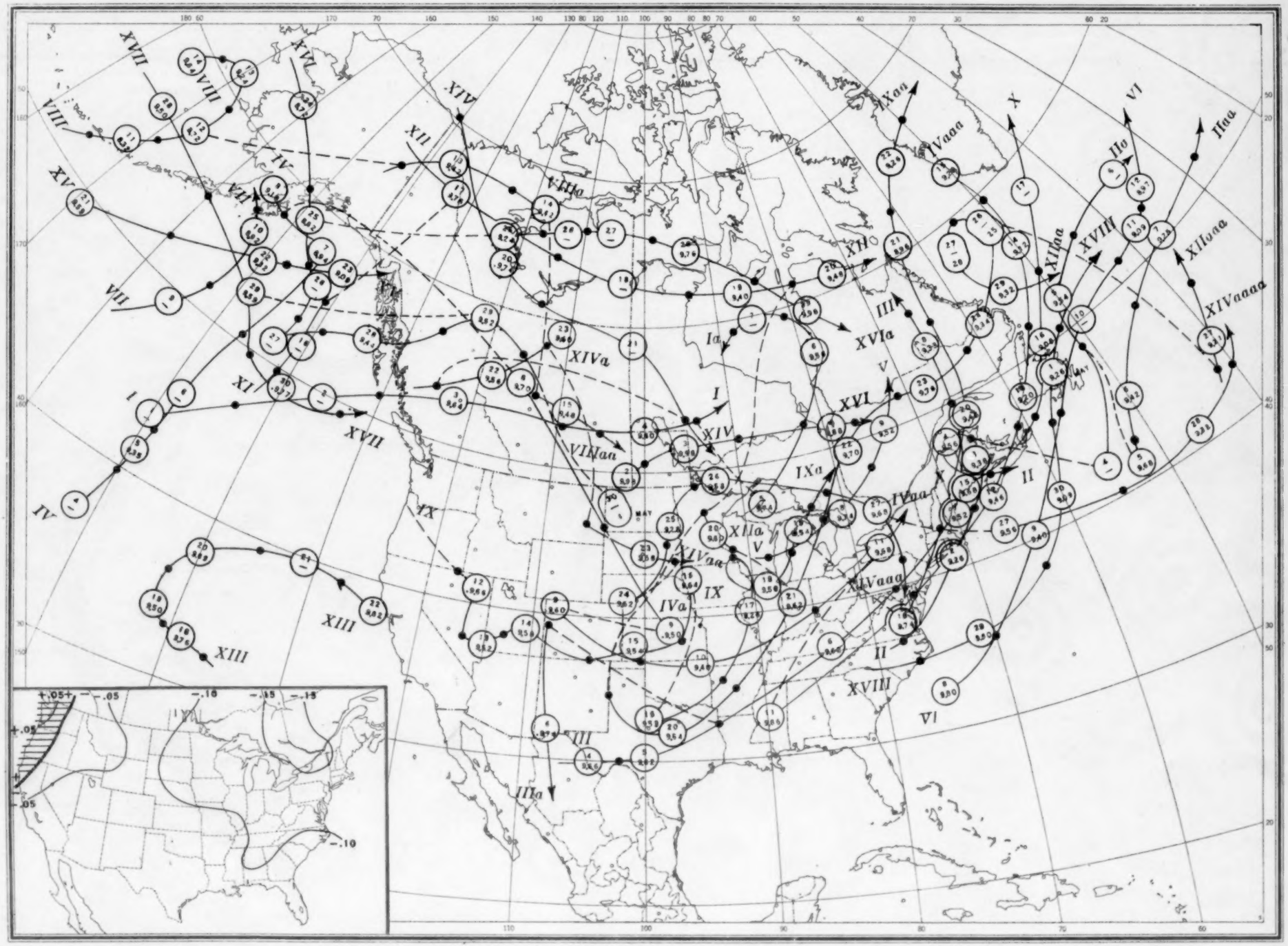
Chart II. Tracks of Centers of Anticyclones, April 1939. (Inset) Departure of Monthly Mean Pressure from Normal



Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, April 1939. (Inset) Change in Mean Pressure from Preceding Month



Circle indicates position of cyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 7:30 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, April 1939

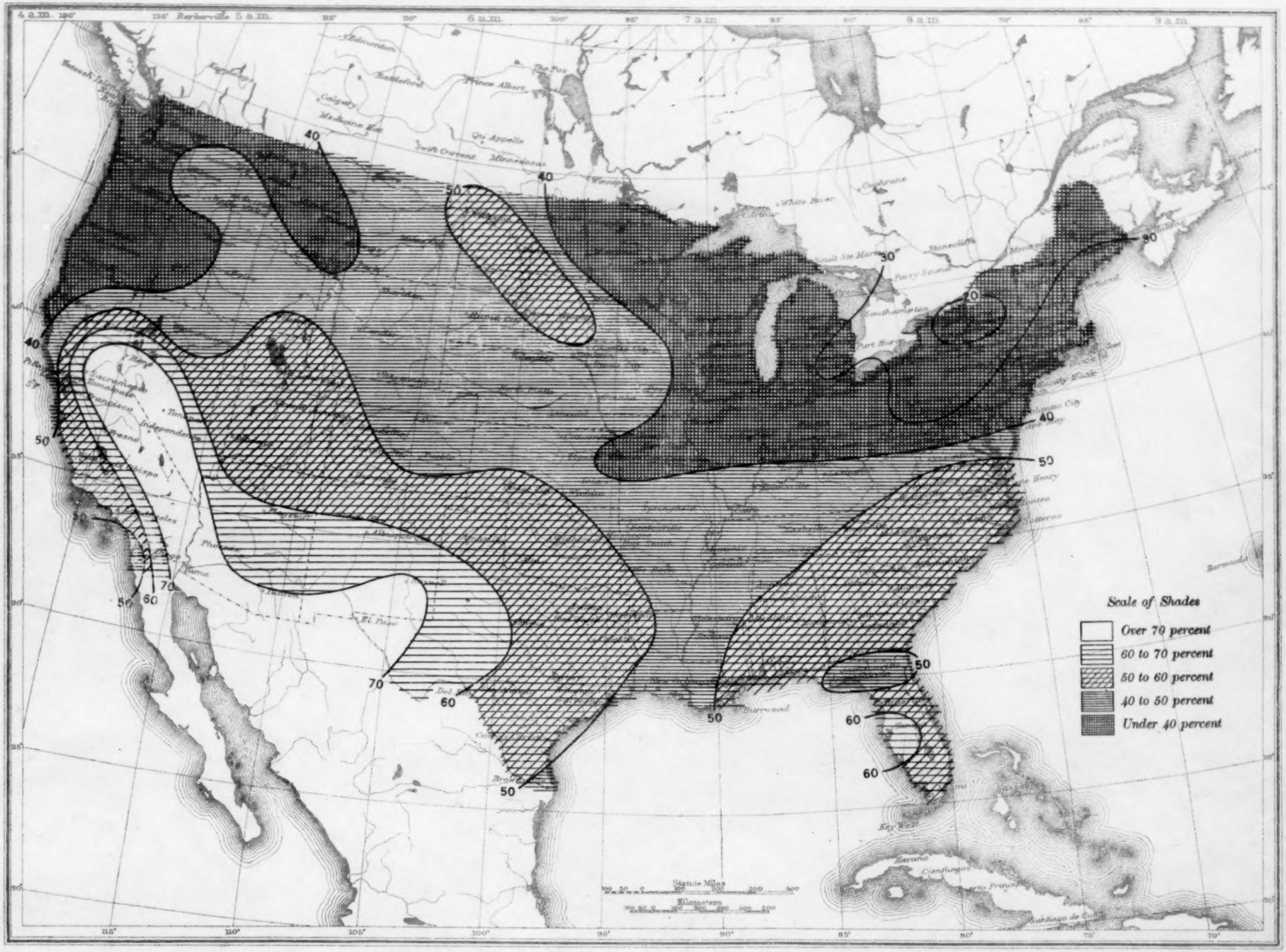


Chart V. Total Precipitation, Inches, April 1939. (Inset) Departure of Precipitation from Normal

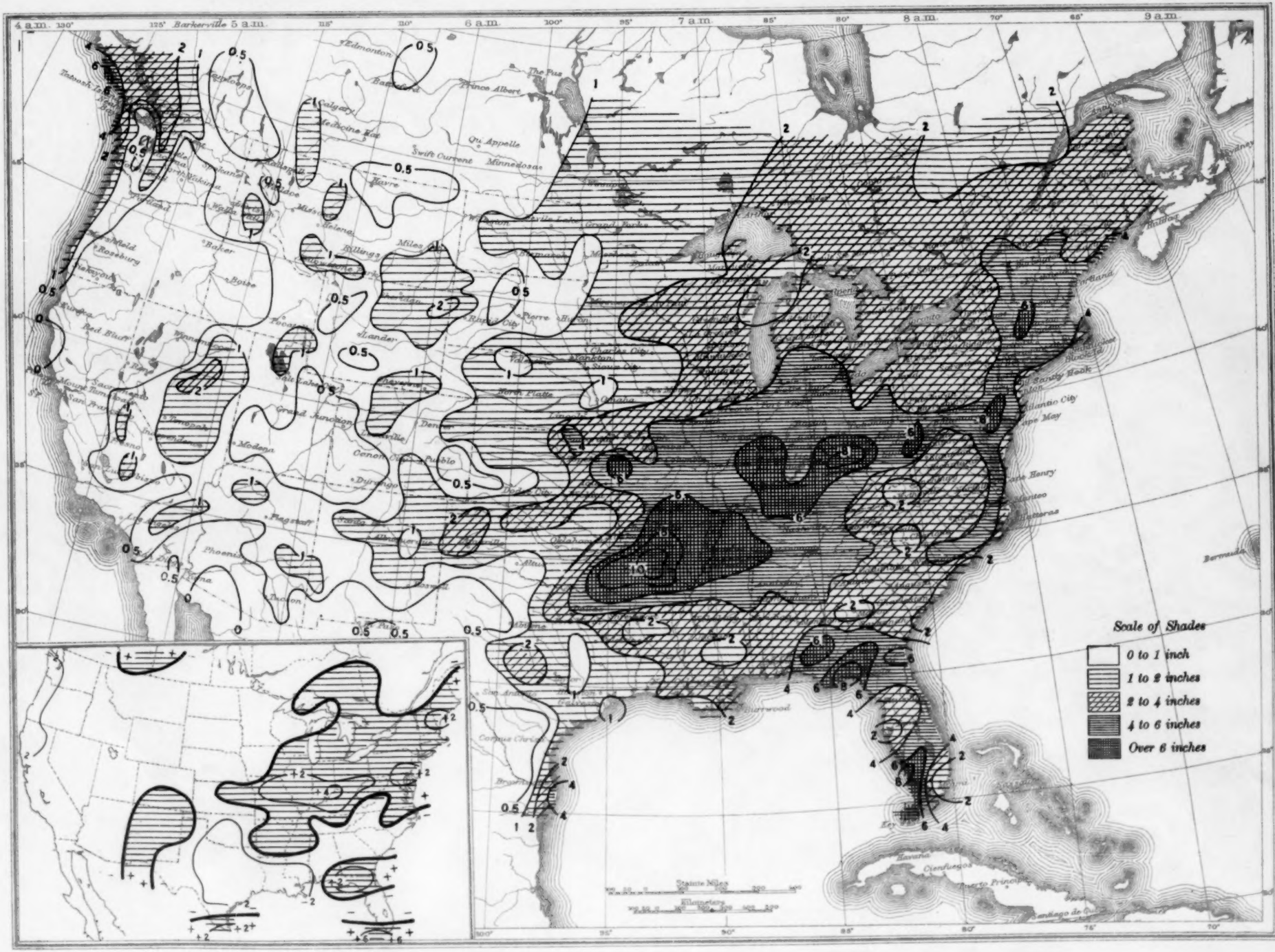


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, April 1939

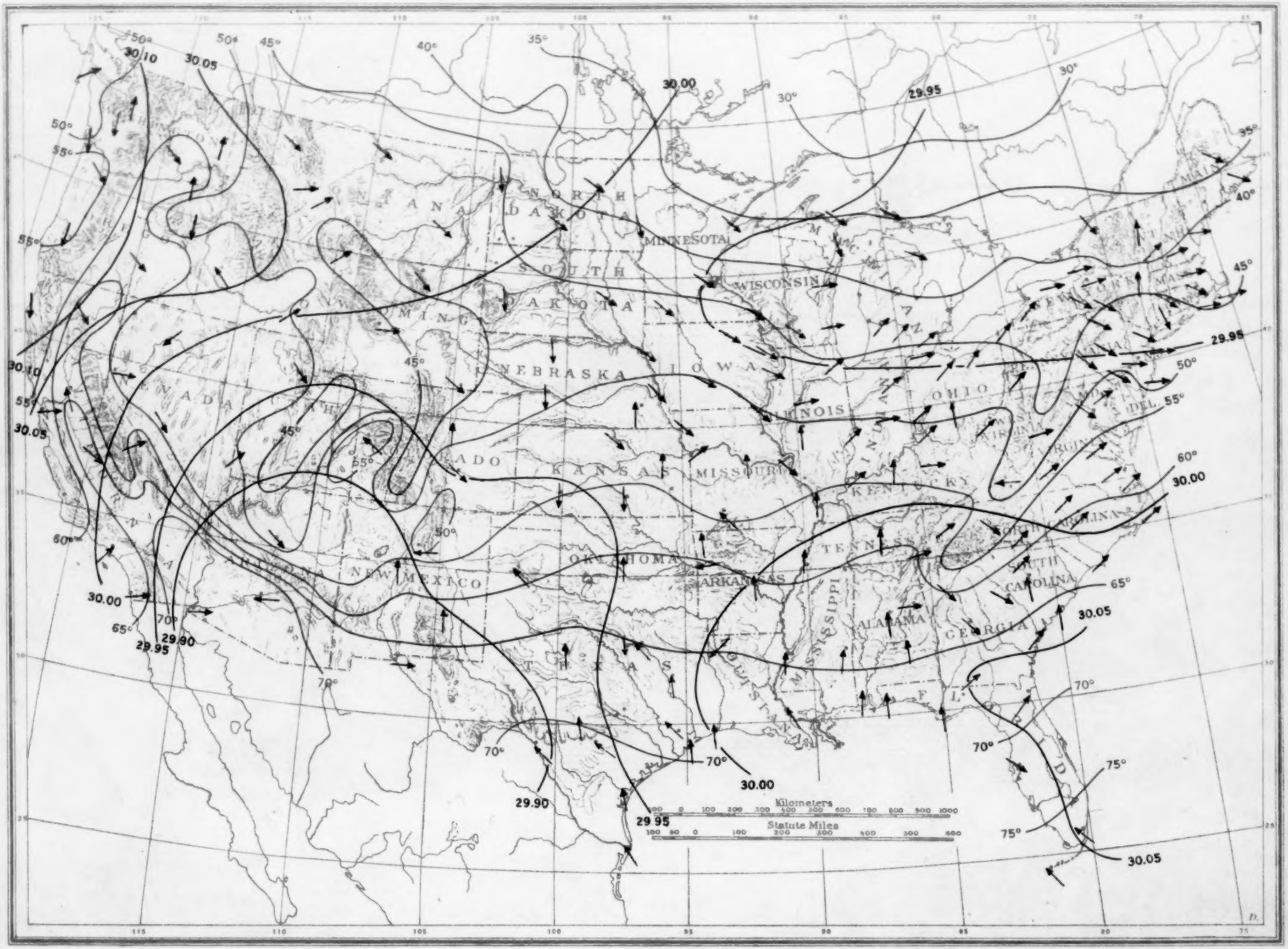


Chart VII. Total Snowfall, Inches, April 1939.

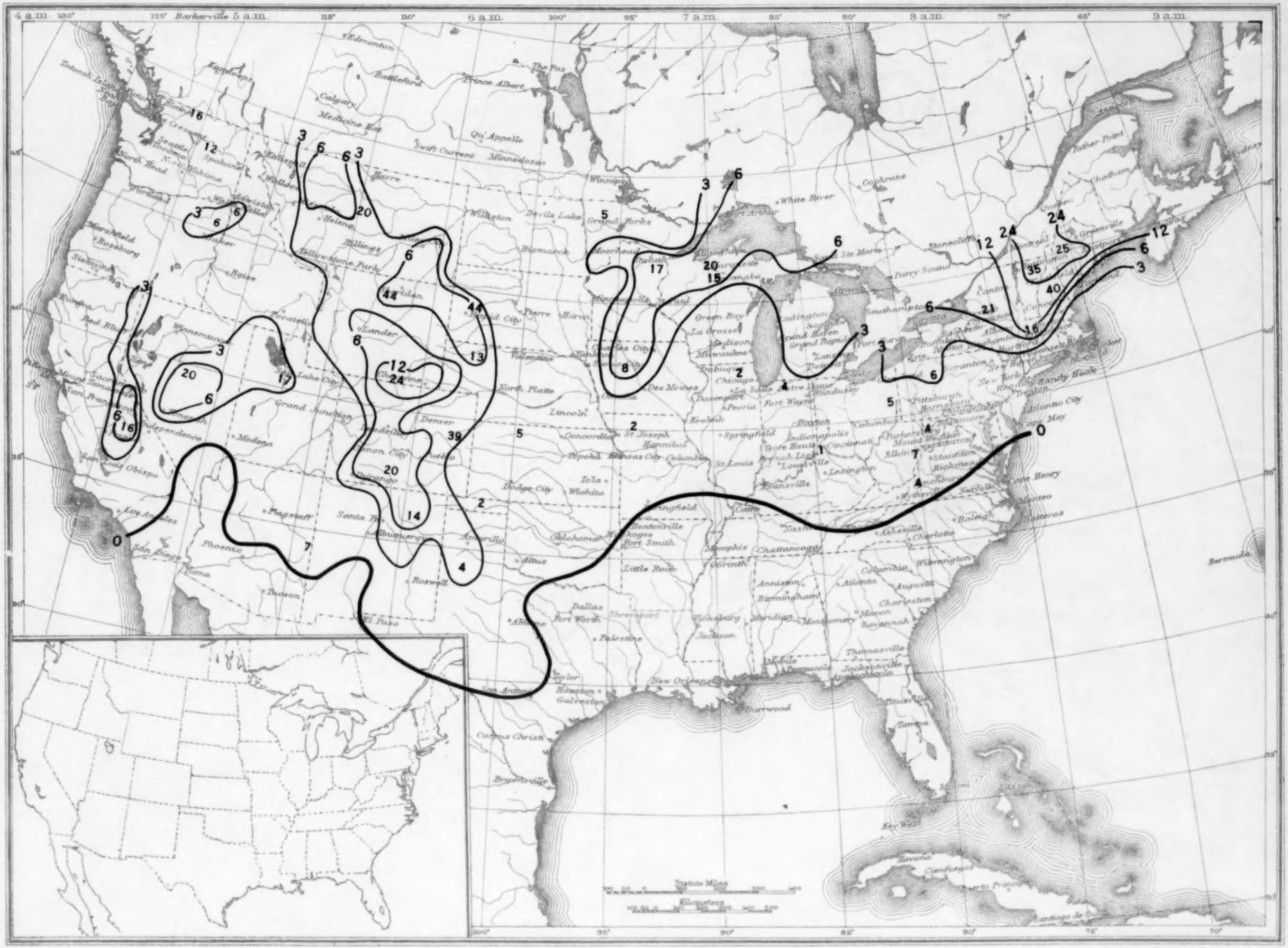


Chart VIII. Isobars (mb) for 1,524 Meters (5,000 ft.) and Isotherms (°C.) and Resultant Winds for 1,500 Meters (m. s. l.) April 1939

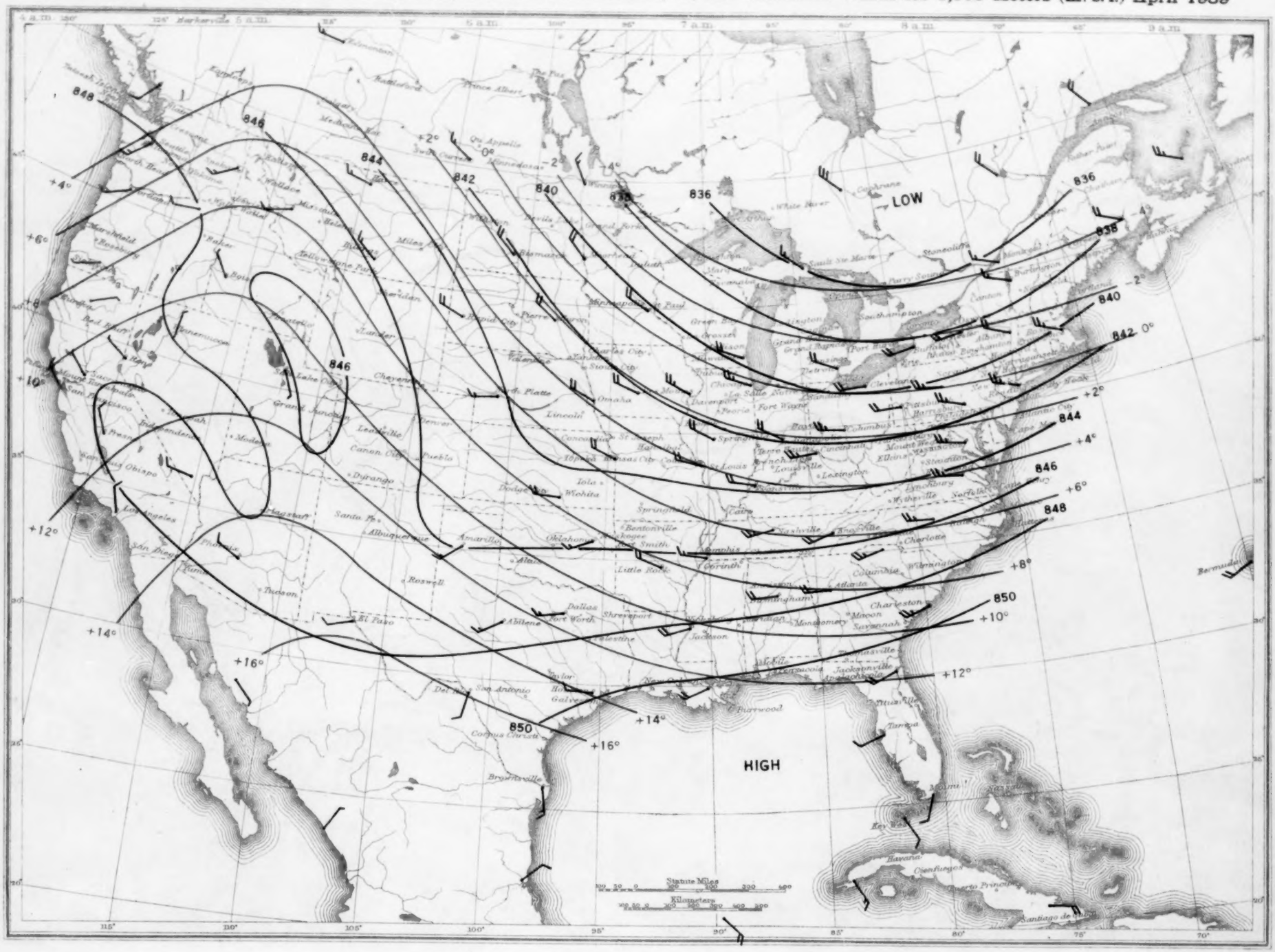


Chart IX. Isobars (mb) Isotherms (°C.) and Resultant Winds for 3,000 Meters (m. s. l.) April 1939

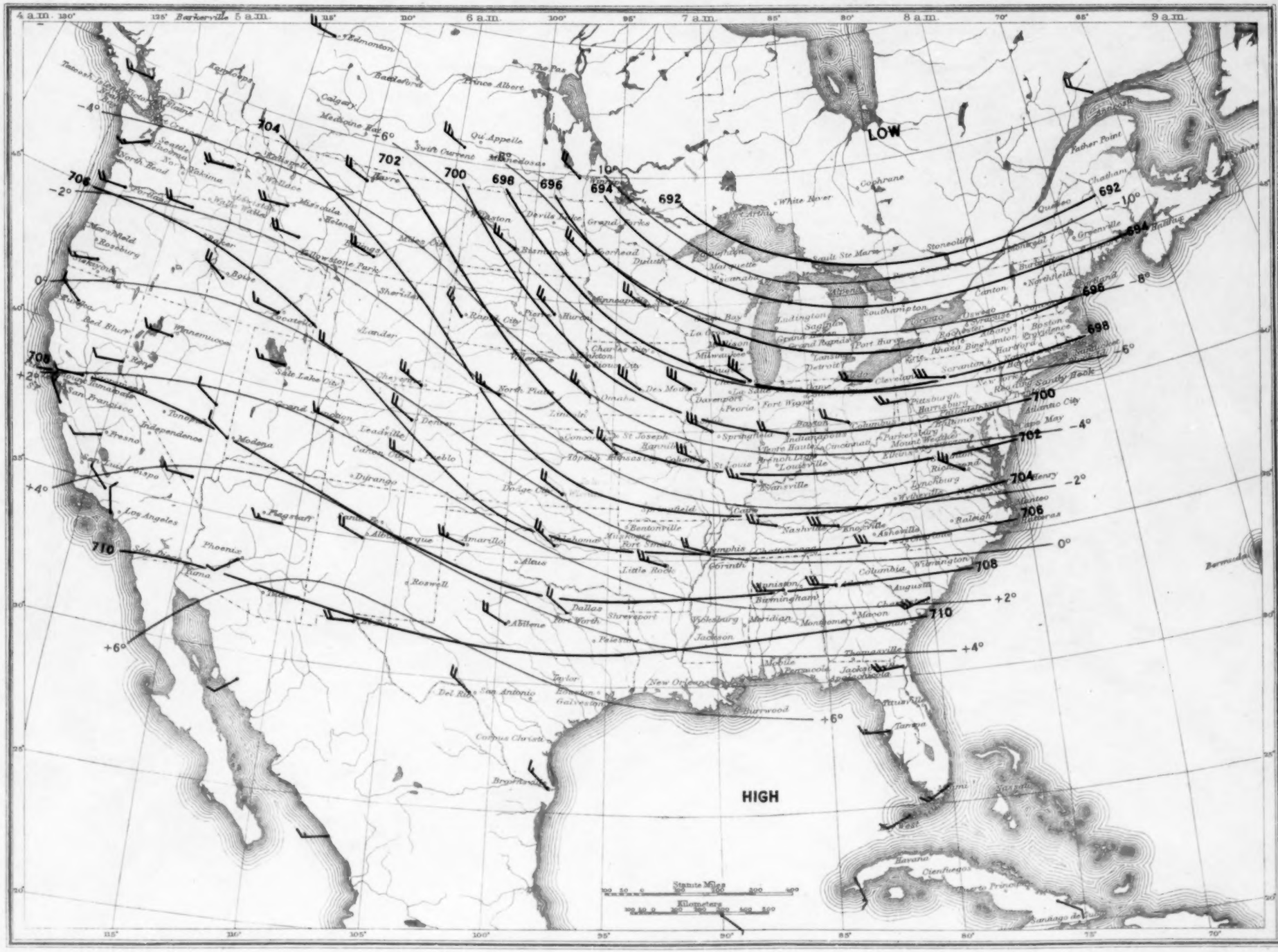


Chart X. Isobars (mb) Isotherms (°C.) and Resultant Winds for 4,000 Meters (m. s. l.) April 1939

Chart XI. Isobars (mb) Isotherms (°C.) and Resultant Winds for 5,000 Meters (m. s. l.) April 1939

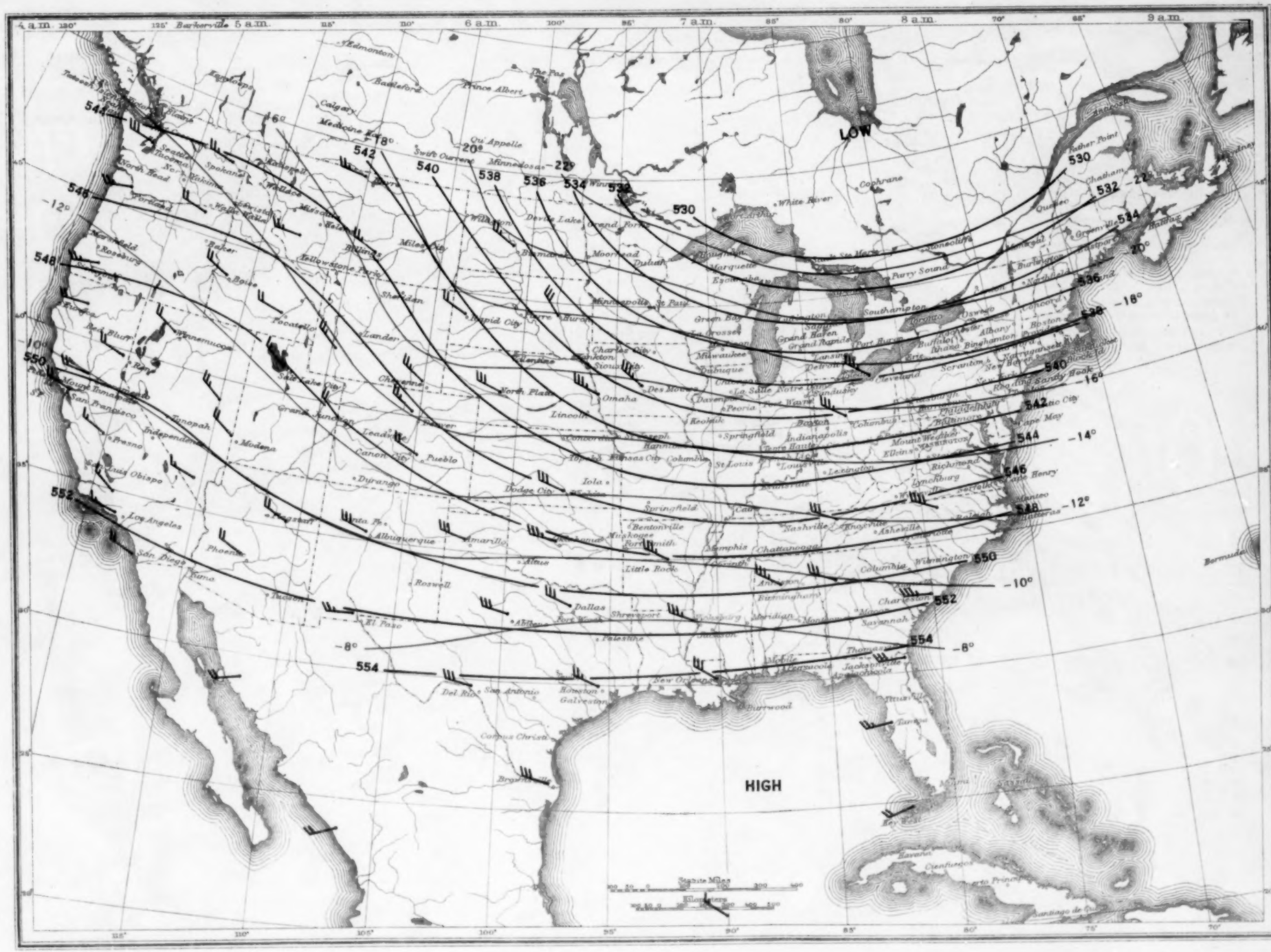


Chart XII. Mean Isentropic Chart, April 1939 (Potential Temperature 301° A.)

MOIST
DRY
MOIST
Ground Inversion
1500m
Red lines indicate condensation pressure in millibars.
Black lines indicate pressure at isentropic surface in millibars.
Resultant winds from 5 p. m., E. S. T. observations indicated by the letters (p. m.); other winds, from 5 a. m. observations.
Winds, for which the level of the isentropic surface is known only approximately, are indicated by elevation.
ARRANGEMENT OF DATA ABOUT THE STATION CIRCLES
Number of observations
Actual pressure
Saturation pressure
Relative humidity
Statute Miles
Kilometers